# ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. LI. No. 22. New York, June 2, 1904.


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### CHARLES HAYNES HASWELL.

(With Inset Portrait.)

Charles Haynes Haswell, M. Am. Soc. C. E., M. Inst. C. E., who is probably the oldest civil and mechanical engineer in the world still actively practicing his profession, was born on North Moore St., New York city, May 22, 1809. His father, Charles Haswell, was a native of Dublin, and was connected with the English diplomatic service. His mother, Dorothea Haynes, was the daughter of Richard Haynes, of Barbadoes, in which island this royalist family sought refuge after the defeat of Charles I. at the battle of Worcester. The Haynes family was prominent in the political and social life of Barbadoes; one of the brothers of Mrs. Haswell having been Speaker of the Barbadoes Assembly and Lieut.-General of the royal forces on the island, and another brother was a captain in the royal navy.

Charles Haynes Haswell received a classical education at schools in New York city and at Jamaica, Long Island. Among his classmates were the late Hamilton Fish, ex-Secretary of State of the United States; Theodore S. Fay, and Edward Minturn. In 1828 he entered the steam engine works of James P. Allaire, then the largest establishment of its kind in the United States. Here Mr. Haswell acquired a theoretical and practical knowledge of marine and mechanical engineering; and his progress was so rapid and so marked that in 1835 he was requested by the Commissioners of the U. S. Navy to submit designs for the engines and boilers of the U. S. Steam Frigate "Fulton," then on the stocks in the Brooklyn Navy Yard. His designs were accepted at Washington, and on July 12, 1836, Mr. Haswell was appointed Chief Engineer of this ship and assigned to superintend the construction of her machinery.

Upon the completion of the "Fulton" he was ordered to sea with her as chief engineer, and he cruised in that vessel until he was detached and assigned to duty as a member of a board appointed to design two large steam frigates—the "Missouri" and the "Mississippi." With this latter duty performed, Mr. Haswell next superintended the building of the U. S. S. "Michigan," on Lake Erie, and he was later assigned to the U. S. S. "Missouri" as her chief engineer. At the end of the cruise of the "Missouri" a change was proposed in her smokestacks; and some one in authority advocated two stacks of 3.5 ft. diameter in place of one of 7 ft. diameter, under the mistaken assumption that the areas were equal in both cases. Mr. Haswell strongly protested against this absurd substitution; but his protest was adjudged to be disrespectful and he was suspended from duty for insubordination. When the two 3.5-ft. stacks had been put in place and tested it was found that Mr. Haswell was right, and he was informed that he might return to duty if he would only apologize to his superior officer for his "insubordination." Against the advice and pleading of his fellow officers, Mr. Haswell replied: "I prefer to submit to an injustice from others than to do an injustice to myself. I decline to make any apology, as I owe none." He was then detached, and while awaiting orders he designed and directed the construction of the engines and boilers for the U. S. S. "Allegheny" and for four revenue cutters.

In October, 1843, Mr. Haswell was commissioned Engineer-in-Chief of the United States Navy. This was actually the first appointment made under the Act of Congress designating a trained marine engineer for this position. For eight years Mr. Haswell held this office. And it was largely through the representations of Mr.

Chas H. Haswell

(Reproduced from an engraving by Illman & Sons, in the "Democratic Review," New York, 1843.)

Haswell to Congress that the Steam Engineering Corps of the U. S. Navy was later organized, a corps that has rendered most efficient service in three wars. In 1851, Mr. Haswell was superseded as Engineer-in-Chief by a man "utterly ignorant of the operation of a steam engine, who could not correctly explain why a body lighter than water floats in it." The fact that his successor was appointed to office as a reward for condoning an offense against society, made the injustice of the act even greater. Immediately after this, though a medical board had declared Mr. Haswell unfit for duty, as the result of a malarial fever contracted in his office, then located on the Potomac Flats, he was ordered to sea by a chief clerk in the absence of the Secretary of the Navy. He was otherwise persistently annoyed by some of those in authority over him; and believing himself to be most unjustly and outrageously treated, Mr. Haswell resigned from the service in 1851, and took up the private practice of civil and mechanical engineering in New York city.

As a civil and mechanical engineer Mr. Haswell designed and superintended the construction of a number of merchant steamships and smaller vessels and was much engaged in engineering work in the vicinity of New York, including among them the improvement of Riker's Island. In 1855-57 he was a member of the Civil Board of Councilmen of the City of New York, and in 1858 he was president of that body. He was successively engineer to the New York Board of Health, superintending engineer to the Department of Charities and Correction, and consulting engineer to the Board of Public Improvements. He was a trustee of the Brooklyn Bridge, and under the new city charter, Mr. Haswell was made assistant engineer to the Board of Estimate and Apportionment, and he still performs the duties of this last office, never missing a day at his office in bad weather as well as in good. While this is the merest outline of the long and active professional career of Mr. Haswell, it is difficult to enter into detail owing to the fact that his contemporaries have passed away, and of his personal engineering achievements Mr. Haswell modestly declines to speak.

To Mr. Haswell must be ascribed the creation of the modern steam yacht. Prior to 1840, he designed and built at the Brooklyn Navy Yard the "Sweetheart," a small vessel of this type, which attracted the attention of thousands when it made its maiden trip on the East River. He was also the first to suggest and use the galvanic properties of zinc in connection with the prevention of corrosion in marine boilers from the action of sea water. Mr. Haswell actually used zinc for this purpose about thirty years before the same thing was advocated in England and there claimed as new. He acknowledges, however, that he had some difficulty in introducing it into the United States Navy, and speaks of one "intelligent" officer who suspended the zinc in the steam drum, carefully keeping it out of the water.

In 1847-48, when marine engineering was in its infancy, here and abroad, Mr. Haswell proved his own professional ability by designing the complete engine and boiler equipment of the U. S. S. "Powhatan." Owing to the want of trained assistance he made unaided—not only the first designs—but the working drawings for the machinery of this ship, and he directed the construction himself, introducing a number of what were then new ideas into her design. This warship did long and most efficient service in our navy. With Commodore M. C. Perry, the "Powhatan" took part in the memorable expedition to Japan that practically opened that isolated land to the knowledge and commerce of the world. This same vessel played an important part in the Civil War. With her machinery remaining substantially as it came from the hands of Mr.

Haswell, the "Powhatan" was the oldest steam vessel of war in active service when her flag was hauled down for the last time in June, 1886. Forming as she did a part of the first steam navy of this country, she lived to see the birth of the new Navy; and, incidentally, to bear strong testimony as to the professional ability of her designer.

Mr. Haswell has contributed largely to the literature of engineering. His first work, and one that has made his name familiar to all engineers, was his "Engineers and Mechanics Pocket-Book," a compendium of useful engineering knowledge which the aged author is still conscientiously keeping up to date. The Pocket-Book was commenced in 1840 and was first published in 1843; and the 70th edition is now in press. About 130,000 copies have been sold in all, and in this period it has grown from a book of 284 pages to one of 1,051 pages. In 1860 he published his work on "Mensuration;" and in the same year he commenced writing his "Reminiscences of an Octogenarian, of New York City, 1816, 1860," published in 1897. This last is a most interesting series of sketches of New York City as it appeared in the first half of the last century; and as Mr. Haswell has the somewhat unique distinction among prominent New Yorkers of having been actually born in the City of New York, he was in a position to know of what he wrote from intimate personal knowledge. Mr. Haswell has contributed papers to various professional bodies, and probably among the latest of these is his "Reminiscences of Early Marine Steam Engine Construction and Navigation in the United States." This paper was presented in 1897 at the Annual Meeting of the Institution of Naval Architects of Great Britain. In the absence of the author the paper was read by the Secretary; and in referring to it the then President of the Institution, the Earl of Hopetoun, said: "Gentlemen, may I remind you that Mr. Haswell, the author of this paper, is, I fancy, about the oldest practising engineer in the world? He was chief engineer of the United States Navy at the time Her Majesty came to the throne, and that was not yesterday. I may also remind you that he was present at the International Congress held about a year ago, and was about the youngest of us,—he was here, there, and everywhere. I hardly supposed there would be any discussion on this paper, which is a record of facts; and I, therefore, propose that the secretary be authorized to send our best thanks to our veteran friend for his kindness in sending this paper over."

Though well-advanced in years when the Civil War broke out, Mr. Haswell performed his full duty as a citizen and an officer in that momentous struggle. In the early part of 1861 the citizens of New York raised a large fund to be expended in maintaining the Union. On April 23, 1861, a committee representing the organizers of this fund drove up to Mr. Haswell's residence and handed him the letter, which we reprint below verbatim, and of which we have reproduced a fac-simile of the first and last pages:

Commtt. of Citizens of New York.

New York, Apl 23, '61.

Sir: You are deputed to go this ev'g to Washington via Phila & Anapolis, if possible—But to go there at any risk, and to reach the City as soon as possible:

You are to call on the President—Secty of War and Navy—and P. M. Genl.—obtain all useful information & communicate by mail fully when convenient and by telegraph as often as possible—three or four telegrams daily if you find the lines safe.

The points to ascertain are—

1—Where are the Northern Regts

2—Do they want supplies and and what—

3—Where is the safest point to send supplies

4—Does the Govt. need arms & what kind—

5—Does the Govt need provisions and what

6—Does the Govt need more force immediately—

7—We are despatching troops & provisions constantly & actively to Anapolis but can accelerate if the danger is imminent. Do they know it.

8—Do they need Light Artillery & how many rifled batteries

We shall remain in ignorance on these points until we officially here from you by letter or by Telegraph. We shall so act as to urge forward supplies of troops & provisions untill we officially hear from you. These supplies will go to Anapolis & Washn unless otherwise advised by you.

Troops are forming here with great celerity & in great force. The number are without limit—and money provision enough and more than enough for the emergency.

Write & Tel: to Pickering Clark No 10 Wall

9. If Anapolis is not safe—to what point shall we send reinforcements or supplies name place and kind of supplies as before. Answer fully & carefully by mail—and Telegram distinctly & with great care to prevent error.

The Commtt repose confidence in your discretion, prudence and fidelity, and we commend you to the Courtesy of the officers of the Government.

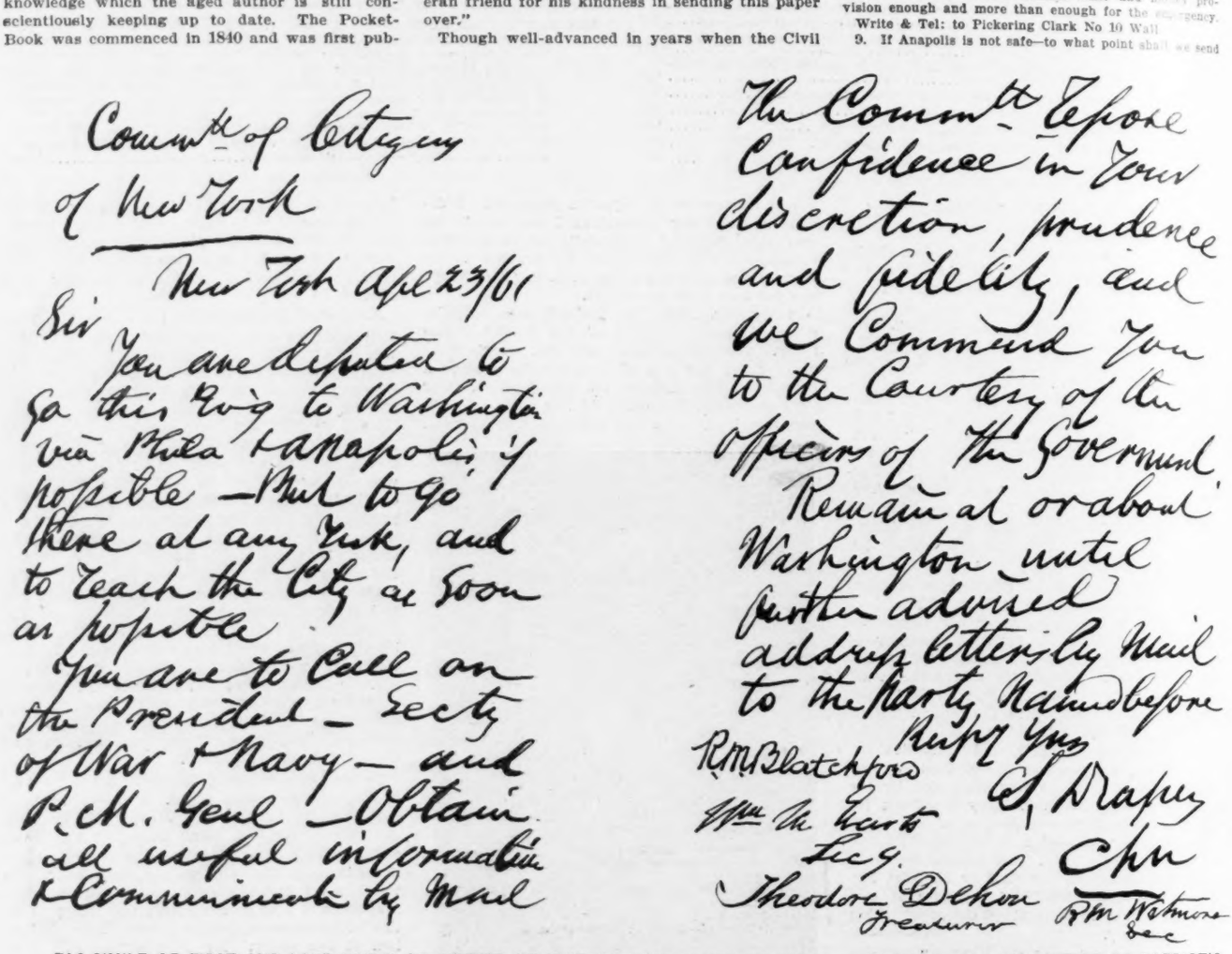
Remain at or about Washington until further advised. Address letters by mail to the party named before.

Respy yours

| | |
|---|---|
| R. M. Blatchford | S. Draper |
| Wm M. Evarts | Chn |
| Secy. | R. M. Wetmore |
| Theodore Dehon | Sec |
| Treasurer | |

Genl Wool is present in active concurrence and it is his judgt that these measures are essential to public safety & that the most active and energetic movements are essential to the safety of the Governt. He is of opinion that Baltimore, Norfolk & New Orleans should be occupied at once & that at least 150 thousand men are required in this exigency—500,000 can be had if required & at command. The whole North is alive and ready to sustain the Union. John E. Wool, U. S. A.

Mr. Haswell left New York by steamer the same day that he received the above letter. He landed at Annapolis, and, joining a Rhode Island regiment, he set out for Washington. Upon his arrival




FAC-SIMILE OF FIRST AND LAST PAGES OF LETTER OF INSTRUCTIONS GIVEN TO CHAS. H. HASWELL BY A COMMITTEE OF PATRIOTIC CITIZENS OF NEW YORK JUST AFTER THE BALTIMORE RIOTS IN 1861.

there he at once went to Mr. Seward and was by him taken to President Lincoln; a Cabinet meeting was called before which Mr. Haswell appeared. A considerable portion of this New York fund was expended for rifles brought from Germany.

In 1862-3 Mr. Haswell was in active service in the expedition of Gen. Burnside against Roanoke Island. Though officially Chief Engineer in the Corps of Steam Engineers, he was in command of a small gunboat; and at the bombardment of Fort Bartow on Roanoke Island, he ran his boat under the fire of the fort and hauled off the U. S. S. "Ranger," which had grounded on a shoal. In a letter to the Hon. E. M. Stanton, Secretary of War, and dated at Headquarters, New Berne, N. C., March 31, 1862, Major-General A. E. Burnside states that Chief Engineer C. H. Haswell "has rendered most important service in his department."

Mr. Haswell has been the recipient of many honors in recognition of his professional services. As long ago as 1854, Nicholas I., the Czar of all the Russias, presented to him a diamond ring, through the Russian Minister at Washington "as an expression of his thanks for the services you have rendered the Imperial Government by the plans and drawings you have transmitted to it on different occasions." Mr. Haswell was made a Member of the American Society of Civil Engineers, Jan. 29, 1868; and of the British Institution of Civil Engineers, on May 5, 1885. He is a Member of the Institution of Naval Engineers of Great Britain, and of the Naval Engineers of the United States; a Member of the Engineers' Club of Philadelphia, an Honorary Member of the Boston Society of Civil Engineers; a member of the Society of Municipal Engineers of New York, of the American Institute of Architects, of the New York Academy of Science, of the New York Microscopical Society and of the Society of Authors. Mr. Haswell is also the oldest living member and the Dean of the Union Club of New York City.

The notable dinner given to Mr. Haswell by members of the Engineers' Club of New York on May 23, in celebration of his 95th birthday, was described in our last week's issue.

Mr. Haswell was married in 1829 to Miss Ann Elizabeth Burns, of New York City, and has had three sons and three daughters. Personally, he is very erect, and is in general good health; and he may be seen almost any day threading his way through the crowded traffic in the vicinity of the City Hall, seemingly as well able to take care of himself in these surroundings as men half a century younger.

## PROGRESS OF PLANS AND WORK FOR REBUILDING BALTIMORE.

By Daniel J. Hauer.*

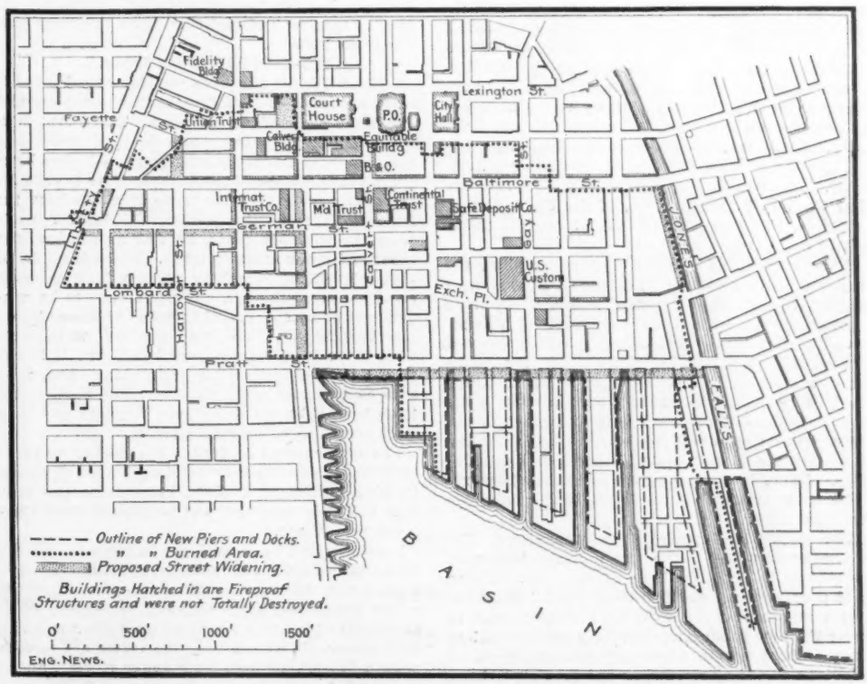
It is seldom that a city with a population of half a million people has the opportunity of planning anew and rebuilding its principal mercantile section. Such an opportunity was, however, presented to Baltimore by the terrible conflagration of February 7 and 8. Municipal officers, engineers and architects throughout the country are interested in what manner the gateway city to the South will avail itself of the chance of remodeling a town laid out in the eighteenth century into a twentieth century city. It is hardly possible to enter into details as to the work now being done, and that planned for the immediate future, but it will, no doubt, be of interest to give a general synopsis of the lines upon which the city is to be rebuilt and show the progress being made.

Fortunately for Baltimore, the Maryland legislature was in session at the time of the great fire, thus making it a comparative easy matter to obtain the necessary legislation to meet the emergency, and both houses of the legislature as well as Governor Edwin Warfield, were prompt in hastening the passage of all acts introduced for the relief of the city.

### BURNT DISTRICT COMMISSION.

Immediately after the fire, Mayor Robert M. McLane appointed a Citizen's Emergency Committee, consisting of prominent business men, engineers and architects, to advise as to improvements necessary and the mode of carrying them out. This body was not an official one, but acted as an advisory board to the mayor. After making a report to the mayor (Eng. News Feb. 25, 1904), the committee adjourned sine die. Acting on their suggestion an act was passed by the legislature creating a Burnt District Commission, consisting of five members, the mayor of the city being a member ex-officio, and giving them the power to acquire land by purchase and condemnation, and to carry out the improvements planned in the burnt district, subject to the approval of the mayor and city council. As members of this commission the mayor appointed Colonel Sherlock Swann chairman; Mr. Reuben Foster, Mr. Charles K. Lord and Mr. John T. Graham.

Colonel Swann has devoted years of his life to the study of municipal improvements, and has traveled both in this country and Europe to familiarize himself with his chosen work. Mr. Foster has long been interested in the shipping trade of the city, being president of some of the local steamship companies. Mr. Lord has been identified with the railroad and coal interests of Maryland, being at one time vice-president of the Baltimore & Ohio R. R. Mr. Graham brings to the help of the commission his vast knowledge of the real estate business of Baltimore, having been an active dealer in this line for a long period. This commission at once outlined the improvements deemed necessary and the proper legislation was prepared and passed both by the legislature and city council.




MAP SHOWING PROPOSED STREET AND HARBOR IMPROVEMENTS FOR BURNED DISTRICT OF BALTIMORE, MD.

### STREET CHANGES.

One of the first projects considered was the widening of the main thoroughfares of the burnt district. The plot of the district as shown in the accompanying drawing gives the original width of the streets and shows the streets to be widened with the new widths marked upon them. Traffic upon nearly all the streets to be widened, with the exception of a part of Lombard St., has at all times been congested, while Lombard St. has been so hilly that the steep grades have prohibited heavy hauling. In addition to increasing the width of the streets shown, a number of the streets in the district as well as Lombard St., between Liberty and Charles Sts., are to be regraded. All this section of Baltimore was never really laid out, but simply built upon and now that the opportunity presents itself, the commission deems it expedient to give the city the best streets possible. The most radical grade revisions are on Lombard St., as stated above, and on St. Paul St., between Baltimore and Lexington Sts. The gradients on these two streets are now between 6% and 8%, while it is proposed to cut them down to less than 2%. The other grade changes will materially improve the other thoroughfares of the burnt section.

In cutting down the streets, approximately 190,000 cu. yds. are to be excavated. This material is to be used in raising the streets near the harbor. The city also expects to utilize a large amount of the debris from the burnt buildings in helping to raise that part of the city, which has heretofore been subject to frequent inundations when water has been backed up by the Patapsco River at times of the hard gales, that come up the bay during the spring and autumn seasons.

Unless otherwise directed by the city council the same class of pavement will be laid on these streets as is now in use. In most cases they are paved with Belgian blocks on a gravel and sand foundation, but on some parts of Lombard St., outside of the car tracks, cobble stones have been used.

The commissioners contemplated widening Baltimore St. (the city's principal thoroughfare) as shown on the plot, but such opposition arose among the property owners that the ordinance authorizing this was defeated in the city council. It will be noticed on the map that West Falls Ave. is to be cut through from Lombard St. to Baltimore St., and the rest of that block has already been bought by the city for market purposes. There is also to be made a plaza 120 ft. wide in front of the west entrance of the court house. It will be noticed that Light St. is to be widened, so that it will be over 100 ft. wide, and Pratt St. is to be 120 ft. This is to be done to accommodate the excessive traffic that frequently becomes congestive there, as well as to act as fire barriers in future destructive conflagrations.

As yet no work has been started on the street improvements, but the commission has purchased a number of parcels of the necessary land, and it now looks as though they will have to enter into condemnation proceedings in order to hasten this work. Then, too, the city council have been slow to approve their plans in this connection, and have called for changes in the ordinances submitted, that have materially altered the original plans of the commissioners. The street widening will in most cases be done by day labor under the direction of the city engineer's department, but the regrading of the streets is to be let out by contract.

### WIRES UNDERGROUND.

It has been decided that no wires shall be strung

*7 South Broadway, Baltimore, Md.

in the burnt district, and the city authorities will not issue any permits for the erection of poles for that purpose. All wires must be laid in the underground conduits, and house connections made with them. The only poles to be allowed on the sidewalks in the burnt section are to be those used for lighting purposes, and to suspend the trolley wires for electric cars, although there is some agitation to do away with the last named poles, and suspend the wires from brackets fastened to the buildings. By an ordinance the erection of poles for awnings in front of buildings is now prohibited.

BUILDINGS AND BUILDING LAWS.

The first work to be done towards rebuilding was to clear away the debris left by the fire. Immediately after the fire was under control large forces were put to work, under sappers furnished by the U. S. Army, tearing down the unsafe walls. Then began the work of cleaning up the immense amount of burnt rubbish, which work is still steadily going on. About 40% of this kind of work has already been done and some 75 buildings have been started. Of these about ten are completed. These buildings are for the most part two and three-story structures of cheap construction, with brick walls and timber floor joists. Repair work has been begun on the low bank buildings that were only partly injured, while, with the exception of the Union Trust Building, corner of Charles and Fayette Sts., the work of rehabilitation has not yet been commenced on the tall fire-resisting office buildings. This work has filled the business part of the city with dust so that it has almost become a menace to both health and business. At present an ordinance is before the council to appropriate $30,000 to abate this dust nuisance. The idea has been to use street sprinklers, but Prof. F. P. Dunnington, of the University of Virginia, has suggested the use of calcium chloride to allay the dust.

The progress made in building seems slow, but a great many obstacles have arisen to prevent a rapid reconstruction of many buildings. In many cases insurance losses could not be settled promptly. The proposed street changes have prevented others from starting buildings until the ordinances authorizing the changes were definitely decided upon by the council, and in some cases the adjoining lots have not been cleared of debris, thus preventing would-be builders from tearing down the party wall, and starting a new foundation. Then, too, some of the work has been retarded by attempting to change and revise the building laws.

The mayor has appointed a committee, the chairman of which is the city building inspector, to revise the building laws of the city. Up to date they have not finished their work, but one or two temporary ordinances have been passed to cover the new conditions that have arisen. It has been decided not to allow any encroachment of buildings on the sidewalks, as has previously been done. The building inspector in the future is to inspect all elevators at their installation and at least three times a year. The most important ordinance passed in this line is as follows:

Sec. 2. Be it ordained, that no building or buildings shall hereafter be erected over eighty-five feet in height from the established street level unless the same are fireproof throughout.

Sec. 3. And be it further ordained, that no buildings of any character shall be erected over one hundred and seventy-five feet in height from the established street level.

Sec. 4. And be it further ordained, that the face brick of all walls shall be bonded to the walls with bricks, and not with metal ties.

Sec. 5. And be it further ordained, that "look-outs" for all metal cornices shall be of metal.

Sec. 6. And be it further ordained, that the Inspector of Buildings shall not permit the erection of any building higher than eighty-five feet unless the material used in such construction shall have been approved by him as fireproof, and only such approved material shall be used.

Sec. 7. And be it further ordained, that the provision of sections 2 and 6 of this ordinance shall apply to all buildings now existing where application is made to add to their height.

Sections two and six of this ordinance have caused dissatisfaction among property owners, as the city officials have construed these sections to mean that no combustible material can be used in constructing a building over 85 ft. high. This would necessitate tile or concrete floors without wooden flooring laid upon them, metal doors and sashes and wire glass, without wood partitions being allowed in the rooms. Property owners aver that this will make a building so expensive to construct that it will be a non-paying investment and at this writing there are two substitute ordinances before the council materially changing these sections.

If the new revision of the building laws will make a more fire-resisting building and also aid in making economical construction, it is to be hoped that the committee will complete their work quickly so that the new laws can be applied to all structures to be built this summer. In order to see that the building laws are being carried out inspectors visit each building in the burnt district daily, and as the construction work increases additional inspectors will be put on. At present it looks as though Baltimore will be built up so that such a destruction as has just occurred can be duplicated, for buildings built of combustible materials will be mixed in with fire-resisting structures and a fire once started can again get beyond the control of the fire department.

One thing of interest to be noticed is that few buildings are being erected with stone work, and where it is being used, it is only for ornamentation. Then, too, many banking institutions in rebuilding are rejecting plans for sky-scraping fire-resisting office buildings, and insisting on a low structure designed only for their own use. These are two lessons taught property owners by the fire, as the low fire-resisting office buildings suffered but little.

NEW PIERS AND DOCKS.

On May 17, the city by a popular vote decided to make a $6,000,000 loan to build the new piers and docks, as outlined on the map. The Burnt District Commission is to acquire the land needed and the city is to build the new piers and then lease them. It is contemplated at these piers to care for the oyster and vegetable trade from the bay, the fruit trade from the tropics, the lumber trade from the southern ports, as well as some of the coast and ocean steamer trade. There is no doubt that this will be one of the greatest improvements resultant from the fire. The piers are to be constructed of masonry, either stone or concrete, on pile foundations. The cost and use of concrete piles is to be carefully considered, but it is expected to use timber piles as in many cases piles have been pulled out of the Baltimore harbor that have been submerged for over 75 years and they were found to be as good as new.

The city expects to dredge the harbor so as to conform to the bill now pending before Congress to give Baltimore a 35-ft. channel to the bay. This bill, it is expected, will be passed when Congress reconvenes.

Buildings will be erected on the piers to suit the needs of tenants, and already applications have been made for space. These harbor improvements are to cost approximately $4,000,000, while $2,000,000 of the loan are to be used for street improvements. Within a year the voters are to vote upon a $10,000,000 loan for a sewer system, and a $2,000,000 loan to improve the "Annex." The pier and dock work is to be let by contract.

The Burnt District Commission is to have charge of all these improvements, while the City Surveyor makes the surveys and locates the work. The actual construction of the street work is done under the direction of the City Engineer, while the harbor work will be under the supervision of the Engineer of the Harbor Board. These officials cannot spend money until ordinances authorizing it are passed by the city council, and this provision of the law has allowed the council to change the plans of these engineers until in some cases their good work towards building a better city has been made fruitless.

During the next few months the work of rebuilding will be considerably accelerated and by winter many buildings in the burnt district will be finished and occupied. Baltimore will certainly be rebuilt in many ways a better city, if not all the improvements that could be hoped for are made; and many lessons have been learned by engineers from her disaster.

The writer is indebted to Mr. Reuben Foster of the Burnt District Commission; Mr. B. T. Fendall, City Engineer; Mr. Raleigh C. Thomas, City Surveyor; Major H. N. Hutton, Harbor Board Engineer; and Mr. H. S. Cooper, of the Building Inspector's Office, for information furnished.

## SOME TESTS OF HIGH-SPEED CENTRIFUGAL PUMPS.

The use of high-speed centrifugal pumps for handling water under high heads is rapidly extending and among the manufacturers who have entered this interesting field is the De Laval Steam Turbine Co., of Trenton, N. J. This company builds centrifugal pumps geared directly to its steam turbines and drives the pumps at such high rotative speed that a pump of comparatively small diameter will deliver water against a high head.

Tests of three of these centrifugal pumps of different types were made last month at the company's works by Prof. Jas. E. Boyden, of the Stevens Institute of Technology and Prof. Wm. Kent, of Syracuse University. A copy of the report made by these engineers has been furnished to us, and we present the following condensation of its contents:

The object of the tests was to record the performance of the pumps and motors in the following particulars:

(1) To measure the efficiency of the pumps, or the ratio of the water horse-power of the pumps to the brake horse-power of the motors, over a range of heads, and water delivery sufficient to determine their maximum efficiency, and at the same time show that the proportions of such pumps can be so controlled as to cause the maximum efficiency conditions to coincide with any desired amount of lift and water delivery. This object was accomplished by the direct measurement of the brake horse-power in the case of pumps No. 1 and No. 2, for which efficiency curves are given, Figs. 1 and 2. The brake horse-power of the two-stage pump, however, could not be determined without the construction of a new shaft to accommodate a prony brake. This was not feasible in the interval available for the test. The location of the conditions of maximum efficiency of the two-stage pump must therefore be inferred from the duty curve of Fig. 3.

(2) To determine the economy of the steam driven pumps as measured by the duty in millions of foot-pounds per thousand pounds of commercially dry steam, or as measured by the pounds of steam consumed per hour per water horse-power. To accomplish this object the steam consumption of the motors of pumps Nos. 1 and 3 was measured by the use of a surface condenser, and the results are shown by the duty curves of Figs. 1 and 3.

(3) To provide the means of determining the economy of the electrical driven pump, by recording the brake horse-power of its motor at various lifts and water deliveries of the pump, whereby the duty of a pump per unit of electrical energy supplied to any electric motor driving it can be determined, when the ratio of the brake to the electric horse-power of the particular motor used is given by its makers. This object is therefore attained by the production of the "brake horse-power and gallons curve" of Fig. 2.

GENERAL DESCRIPTION OF TESTS.

Each pump was arranged to lift water about 3 ft. from a storage tank in the floor of the testing room, and to deliver it to a weir tank, through a throttle valve at the outlet of the pump case, and thence through about 15 ft. of pipe terminating in a vertical converging nozzle, whose outlet was located about a foot above the top of the back end of the weir tank. One inch below the center of the nozzle was located one end of a thin ½-in. brass tube, tapered so as to make an orifice of 3-32-in. diameter. The other end of this tube was connected to a vertical glass tube, fastened to the wall of the testing room, graduated in inches over a height of about 30 ft. The stream of water issuing from the nozzle impinged upon the 3-32-in. orifice of the brass tube, and thereby maintained a height of water in the glass tube. This height afforded a Pitot tube basis of measurement of the quantity of water flowing, the reliability of which was tested by the flow as determined from the weir.

Each pump was first run at its governor speed, and the delivery measured under approximately the designed total head, or total lift, which was found as follows: The total head, or total lift, is the sum of the suction and the delivery pressure, both expressed in feet head of water. The suction was determined by a mercury gage placed in the suction pipe near the pump case, and the delivery pressure by a pressure gage inserted in the delivery pipe near the pump, at the same level as the point of insertion of the mercury gage. The suction pipe and delivery pipe being of same diameter, no correction for difference in velocity in these two pipes is required. In the case of the No. 3 pump the delivery pipe, where the gage was attached, was of smaller diameter than that of the suction pipe, but the error due to neglecting this fact is insignificant in view of the high pressures involved. This total head, or total lift, was multiplied by the weight of water delivered in computing the water horse-power.

The total head was then increased and decreased during the different tests by means of a throttle valve in the delivery pipe, and the water delivery at different heads was measured so as to secure points of a curve of "total lift and gallons" on either side of the designed conditions, as shown by the diagrams. The total head, or total lift, with

zero gallons, or with the throttle valve closed, was observed with each pump, to locate the left extremity of the curve, the tabulated data in the tables for this condition being marked "Shut Off." The conditions for which the pumps were designed are marked on the "total lift and gallons" curve by a shaded angle.

CALIBRATION OF WEIR AND PITOT TUBE.

The dimensions of the weir tank were 14 ft. long, 6 ft. wide and 6 ft. deep. It was designed of such capacity that two minutes were required to fill it with the largest rate of flow through the nozzle, and the latter was so fitted that it could be swung over or off the weir tank in less than half a second. Hence we were able to use the weir tank as a measuring basin to determine the rate of flow at any given reading of the Pitot tube, with an error, from spill in diverting the stream into or out of the tank of less than ½ of 1%, and thereby by comparing the Pitot reading with the corresponding weir reading calibrate both the weir and the Pitot tube in a very satisfactory manner. The result of such calibration with two sizes of nozzle and of weir, show that the Francis standard formula: $Q = 3.33\ [L - .2\,h]\ h^{\frac{3}{2}}$ applied for the conditions of weir used, with an error of less than 1%, the velocity of approach being neglected, as it did not exceed 1-7 of a foot a second. The Pitot tube gave the same result as the weir from the formula $Q^1 = C \times \text{Area of Nozzle} \times \sqrt{2\,g\,h}$ with a value of C varying only between .953 to .977 for the large nozzle, and between .942 and .960 for the small nozzle.

This Pitot tube basis of measurement is that adopted in the testing room of the De Laval Co. for determining the delivery of its pumps, using the value of C = 0.95, with different sizes of converging nozzles for different rates of flow, so that the value of h is not less than 4 ft. It appears from the above figures that this practice is sufficiently accurate for most practical purposes, and in view of its great convenience is to be recommended as an acceptable system for rating the capacity of the pumps.

The weirs used were made of ¼-in. brass plate with edges chamfered at 45°, so as to leave a flat surface ⅛-in. thick for the orifice. The notches were rectangular and 24 ins. wide for pumps Nos. 1 and 2, with values of h varying from 0.8 ft. to 0.5 ft., and 12 ins. wide for No. 3 pump, the value of h varying from 0.4 to 0.3 ft. The measurements of the depth of water over the weir were made by a hook gage placed in a half barrel of water adjoining the tank, and connected to the latter by a 1-in. pipe, which was laid to a point in the bottom of the tank 6 ft. back from the weir, with its open end at right angles to the flow. Readings of the hook gage were easily made to .001 ft., an incandescent lamp being used to facilitate the reading.

STEAM AND ELECTRICAL MEASUREMENTS.

The steam consumption was measured by exhausting the motors into a surface condenser and weighing the delivery of the latter's air pump on a calibrated platform scale. Tests were made to determine that the delivery of the air pump was sufficiently uniform to make the steam consumption measurements over ten minute intervals satisfactorily accurate. The quality of the steam was determined by a calorimeter, which showed moisture not exceeding 1.7%. No correction was made for this moisture in computing the steam consumption, the steam being considered "commercially dry." The vacuum was measured at the exhaust chamber of the turbine by a mercury column. The steam and water gages were calibrated by a Crosby tester. The volt and ammeters were Weston instruments, calibrated for the tests by their makers.

PRONY BRAKE TEST.

After making the steam and water tests of the No. 1 pump on April 5, it was removed from its base and a Prony brake substituted to absorb the power of the turbine. This was run at the same speeds as controlled by the governor, and the same pressures of steam below the governor valve that were used in the previous tests of the pump. The steam used by the turbine was again measured and found practically to agree with the steam used by it when driving the pump at the same speed, and with the same steam pressures, and by plotting the record of brake horse-power and steam pressure it was found that the results formed a straight line, giving the following formula: B. H. P. = .4064 × steam press. — 3.5.

This formula was used in calculating the brake horse-power of the test of the large turbine on April 5.

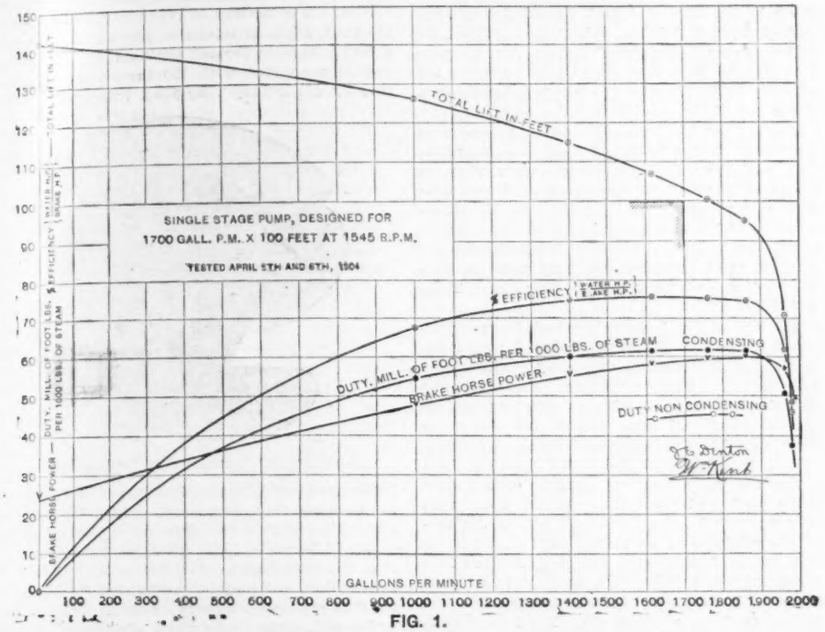

SINGLE STAGE PUMP, DESIGNED FOR
1700 GALL. P.M. X 100 FEET AT 1545 R.P.M.
TESTED APRIL 5TH AND 6TH, 1904
TOTAL LIFT IN FEET
% EFFICIENCY (WATER H.P. / BRAKE H.P.)
DUTY, MILL. OF FOOT LBS. PER 1000 LBS. OF STEAM
BRAKE HORSE POWER
CONDENSING
DUTY NON CONDENSING
GALLONS PER MINUTE

FIG. 1.

RESULTS OF THE TESTS.

Pump No. 1. This was a single-stage centrifugal pump designed to raise 1,700 gallons of water per minute to a height of 100 ft. running at a speed of 1,545 revolutions. It had 8-in. suction and discharge pipe and the pump runner was 13.75 ins. in diameter. The pump was driven by a 55-HP. De Laval steam turbine with a gear reduction of 10. The results of the test of this pump are summarized in the report as follows:

The large steam driven pump delivered a maximum quantity of 1,978 gallons per minute against a total lift, including suction, of 46 ft., the delivery decreasing to 1,759 gallons per minute for a total lift of 100 ft. and to 1,001 gallons per minute for a lift of 126 ft. When the delivery valve was shut, the maximum pressure shown was equivalent to a lift of 142 ft. with no delivery.

The water horse power of the pump was at a maximum of 44½ horse power for a delivery of 1,760 and 1,860 gallons and corresponding to lifts of 100 and 95 ft., and the horse power decreased when the delivery was either increased above 1,860, with diminishing head, or was decreased below 1,760 gallons with increasing head. The efficiency of the pump, which is the ratio of the water horse power to the calculated brake horse power, ranged from .743 to .756 for delivery between 1,398 and 1,860 gallons per minute, decreasing as the delivery was either decreased or increased beyond these limits. The duty of the pump when the turbine was running condensing ranged from 60 to 61.86 millions of foot-pounds per 1,000 lbs. of steam within the same limits, decreasing to 54.47 million foot-pounds for a delivery of 1,001 gallons against a total lift of 126 ft., and to 37.43 millions at the maximum delivery of 1,978 gallons per minute against a total lift of 46 ft. Three tests were made with the turbine running non-condensing, which gave a duty ranging from 44.6 to 45.15 millions, for deliveries of 1,629 to 1,826 gallons, and total heads, respectively of 104.42 and 95.14 ft.

The steam per brake horse power, running condensing, ranged betwen 24.06 and 24.53 for delivery between 1,398 and 1,860 gallons per minute, corresponding to heads of 115.5 and 95 ft. These deliveries and heads therefore cover the economical range of the pump and show that the conditions for which it was designed coincide with those of maximum efficiency.

Pump No. 2 was a smaller pump for use under a lower head. It was designed for 1,200 gallons per minute delivery against 45-ft. head and with the runner making 2,000 revolutions per minute. This pump also had 8-in. suction and discharge pipes and the runner was 8.3 ins. diameter. It was driven by a direct-connected electric motor of 20 HP. using direct current at 240 volts.

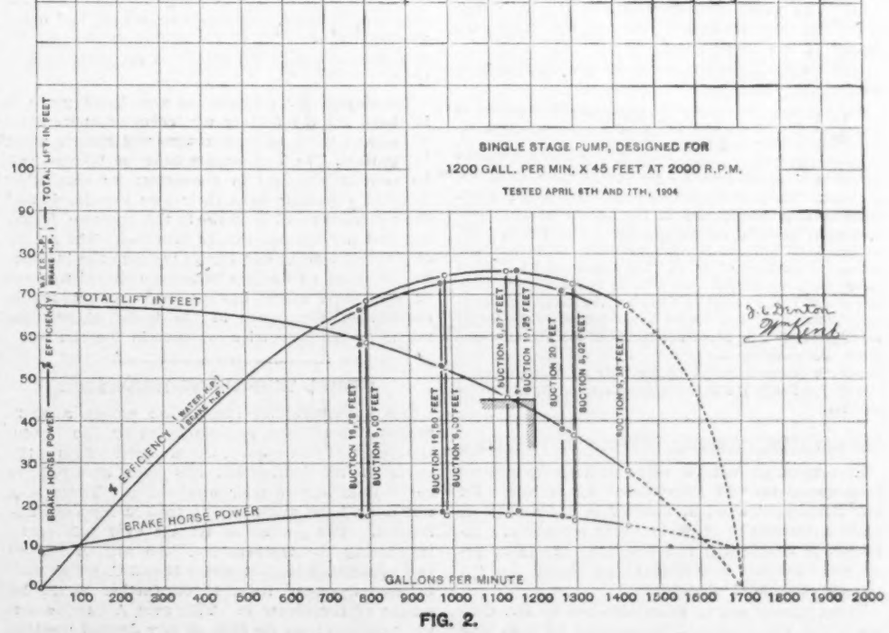

SINGLE STAGE PUMP, DESIGNED FOR
1200 GALL. PER MIN. X 45 FEET AT 2000 R.P.M.
TESTED APRIL 6TH AND 7TH, 1904
TOTAL LIFT IN FEET
% EFFICIENCY (WATER H.P. / BRAKE H.P.)
BRAKE HORSE POWER
SUCTION 10,75 FEET
SUCTION 10,50 FEET
SUCTION 9,50 FEET
SUCTION 8,00 FEET
SUCTION 6,00 FEET
GALLONS PER MINUTE

FIG. 2.

In like manner the pump driven by the electric motor was removed from its base, a Prony brake substituted, and the motor then run at the same volts and amperes as were used during the test of the electric motor pump. These brake tests also gave a straight line formula connecting the brake horse-power and electric horse-power, which is B. H. P. = .954 E. H. P. — 2.04.

Messrs. Kent and Denton reported the results with this pump as follows:

The tests of the electrical motor pump showed a delivery ranging from 790 to 1,403 gallons per minute at total lift heads respectively of 59 and 30 ft. The electrical horse power was 20.11, or 17.14 brake HP., for the smallest delivery at the highest head, and 17.80 electrical HP.,

or 14.94 brake HP. for the largest delivery at the smallest head.

The maximum electrical horse power, or 17.72 brake HP. was attained at a delivery of 986 gallons per minute, and a total head of 53 ft. The efficiency of the pump, which is measured by the quotient of the water horse power divided by brake horse power, ranged from .714 for the maximum delivery of 1,403 gallons per minute to .750 for a delivery of 1,133 gallons, falling to .683 for the minimum delivery of 790 gallons a minute at the highest head of 59 ft. Four tests of this pump were made with the suction throttled to a constant suction lift of 20 ft., to determine if the throttling made any change in the efficiency. With throttled suction, the range of efficiency was .655 to .733, showing a decreased efficiency of only about 2%.

The third pump tested and the most interesting of all, was a two-stage pump designed to deliver water against a head of 700 ft. It comprised

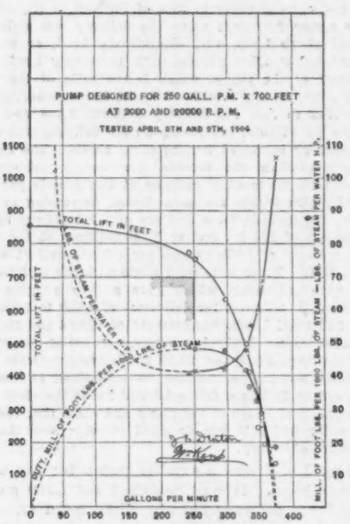

PUMP DESIGNED FOR 250 GALL. P.M. X 700 FEET
AT 2000 AND 20000 R.P.M.
TESTED APRIL 5TH AND 9TH, 1904
TOTAL LIFT IN FEET
LBS. OF STEAM PER WATER H.P.
LBS. OF STEAM PER 1000 LBS. OF STEAM
MILL. OF FOOT LBS. PER 1000 LBS. OF STEAM
GALLONS PER MINUTE

Fig. 3.

a large pump wheel driven from the geared shaft of a De Laval steam turbine and a small pump wheel direct-connected to the shaft of the turbine itself. The large runner was 9 ins. in diameter, and was designed to run at 2,050 revs. per min. for a delivery of 250 gallons per minute. The small runner was 2.84 ins. in diameter and ran at 20,500 revs. or ten times the speed of the large wheel.

The results as summarized by the experts were as follows:

The two-stage, or compound pump, showed a delivery of from 244 to 373 gallons per minute against heads, respectively, of 781 and 136 ft. The water horse power increased from 12.83, corresponding to 373 gallons delivered at 136 ft. head, to 48.15 for 244 gallons delivered at 781 ft. head. The duty in million foot-pounds was a maximum of 48.88 for delivery at the highest head and decreased to 41.55 for 328 gallons delivery at 494 ft. head, and to 18.63 millions for the maximum delivery of 373 gallons at the head of 136 ft. The steam per water horse power per hour ranged from 40.5 for the maximum horse power and highest head to 106.2 for the maximum delivery, lowest head and lowest horse power. This lowest horse power is only about one-fourth of the highest horse power delivered by the pump. Both the electrical and two-stage pumps therefore realize their maximum efficiencies at practically the designed conditions of lift and water delivery.

## THE CARNEGIE TECHNICAL SCHOOLS OF PITTSBURG.

In connection with a very handsomely printed programme for the selection of an architect for the Carnegie Technical Schools in Pittsburg, we have a statement of what these schools are intended to accomplish and how they are to be arranged. From this statement we obtain the following condensed sketch.

These schools are to be established by Mr. Carnegie for the technical instruction of men and women in scientific and industrial pursuits. A site covering 32 acres has been secured adjoining Schenley Park; and the Trustees of the Carnegie Institute have been empowered to carry the project into effect. These trustees have appointed the following gentlemen a Committee on Carnegie Technical Schools: William McConway, Chairman; John A. Brashear, W. L. Scaife, W. N. Frew, James J. Booth, John C. Holmes, Charles L. Taylor and John F. Steel. Arthur A. Hamerschlag is Director. This committee is authorized to engage an architect, determine upon a general plan and proceed with the preparation of working plans, specifications, etc.

The programme calls for the design of six buildings—to be broadly classified as Administration, School of Applied Science, School for Apprentices and Journeymen, Technical School for Women, School of Applied Design, Service. The estimated enrollment is 4,000 students, and some further idea of the scope of the schools may be gathered from the instructions to the architects as to space to be provided. In the School of Applied Science, the divisions of the building cover separate quarters for general instruction, machine design and construction, structural steel design and construction, industrial, metallurgical and electro-chemistry, mining practice, railway practice, applied electricity, steel manufacture, clay working ceramics and glass and foundry practice. Total area 181,600 sq. ft.

In the School for Apprentices and Journeymen, specified space is to be provided for: Superintendence, general instruction, carpentry, cabinet and wood-working, pattern-making, electrotyping, electrical work, house and sign painting, use of structural steel and iron, steam and hot-water heating, etc., blacksmithing and machine forging, plumbing, masonry and plastering, printing, mining machinery, stationary steam engineering, foundry work and machinists' work. Total area 145,700 sq. ft. In the Technical School for Women, the subjects to be taught are: Professional housekeeping, dressmaking and design, librarians and secretaries, bookbinding, stenography, typewriting and bookkeeping, leather and needle work, millinery, cooking, waiting, etc. Total floor area, 94,500 sq. ft. The School of Applied Design is to include accommodations for teaching, interior decoration and design, ceramic art, elements of architecture, glass-staining and stone carving, repousse work, glass-blowing, typographical art, art needle work and furniture design. Total area, 67,900 sq. ft.

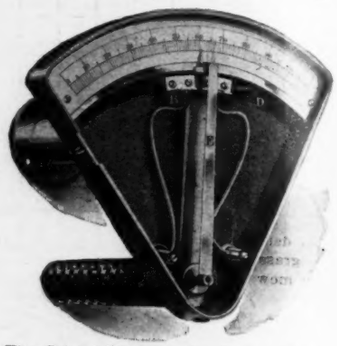
The School of Applied Sciences is to be open to both day and night pupils, and is intended for the training of young men over 16 years of age, during periods of two or three years. The graduates would be fitted for such callings as draftsmen, inspectors, foremen, engineer's assistants and other positions above that of the skilled mechanic. To this end the equipment will be of the most modern type.

The School for Apprentices and Journeymen is intended for the further education of apprentices already at work at trades, who will receive night instruction. The Technical School for Women will be strictly practical in character; its aim being to train women to earn their own livelihood; and the equipment will conform to this purpose. Evening and day courses will be provided. The School of Applied Design has for its purpose the instruction of those who aspire to become skilled workers or designers, after having had a reasonable amount of experience in the technical requirements of the industries included in the courses.

## A NOVEL THERMOMETER-THERMOSTAT.

The accompanying illustration shows a thermometer-thermostat manufactured by The Bristol Company, of Waterbury, Conn. In the figure, the cover of the instrument has been removed, to make clear the interior mechanism. There is a dial 6 ins. long, graduated to read in degrees Fahrenheit. The pointer E travels over this scale, registering the temperature. An arm A carries two adjustable contact pieces B and C, which may be moved closer together or farther apart by means of the screw D. This arm A can be set, by rotation about its axis, at any desired position on the scale, and remains there by virtue of a friction contact. The temperature recorder E, as it moves over the scale, when it touches either the contact piece B or C, rings an alarm, or by means of the electric circuit brings into action the temperature regulating apparatus, whatever it may be. It is one of the novel features of this instrument that the arm E is not restricted in its movement by either of the contact pieces B or C, so that it always records correctly the temperature, whether in excess of or below that for which the contact pieces are set. This arm E is operated by one of Bristol's recording thermometer tubes, placed in the perforated tube projecting from the rear of the case, as shown in the figure.

Where it is desired to regulate the temperature of ovens, kilns, or liquids in pipes under pressure, a small bulb is located within the oven or pipe and is connected with the thermometer-thermostat by a capillary tube filled with alcohol. The



The Bristol Thermometer-Thermostat.

instrument may be readily applied to liquids, as, for example, to indicate and control the temperature of brine in a refrigerating system or tank.

It will be seen, from the foregoing description, that the thermometer-thermostat is flexible in its application, and may be applied wherever it is desired to regulate temperature either automatically or by giving an alarm when the temperature deviates more than is desired from a given standard.

## METHODS AND COST OF SODDING.

By Arthur Hay.*

An engineer or contractor is frequently called upon to estimate cost of sodding banks, for instance, reservoir embankments or earth dams, and as information concerning this work is not found in the ordinary handbook, some data on the details and cost of work may be of interest.

Sod is generally used only for covering banks so steep that grass-seed would be washed away before it could sprout. On slopes gentle enough to hold the seed without washing and on all level places, seed would be used in preference to sod, because it is so much cheaper. Sixty to eighty pounds of seed will sow an acre, at a cost for seed of from $7 to $10, and the labor of sowing and raking it in will be about the same, or a total, say, of $20 an acre. The cost of sodding the same area would be nearly $300; so, unless an immediate effect is desired, and expense is a secondary consideration, seed will be used wherever possible.

The best sod is generally composed of blue-grass and red top, with some white clover, and is found in its greatest perfection in upland pastures fully exposed to the sun, which have been grazed over for years. The constant trampling and cropping seem to consolidate the roots and exterminate the weeds, and sod cut from such a place "rolls like Brussels carpet." Wood sod, or even that cut under isolated trees, is apt to be patchy and rotten. The leaves of the trees collecting in drifts in winter, rot the grass out in spots and cause it to fall to rags when cut, and weeds are more abundant in such places. This is true of all trees except the black walnut, but, for some mysterious reason, we always find the very best blue grass sod growing under a walnut tree. Grass growing in the bottoms where the soil is rich and moisture abundant, looks fine and green, but on cutting it is found that the rank growth is all in the top, that it has not roots enough to hold it together for rolling, and that it is apt to be full of weeds and coarse wild grasses. Moles are also the ruination of good sod. Their tunnels driven just

*Engineer of Parks and Boulevards, Springfield, Ill.

under the grass roots, heave up the sod and break its attachment to the underlying soil, so the roots dry out and the grass dies. When, in cutting, one of these tunnels is encountered, the roll breaks in two, and if, as is frequently the case, the ground is covered with them interlacing in every direction, the sod is worthless. Moles are found everywhere, but seem most abundant in open woods, and least abundant in sunny pastures. So, as was said before, look for the best sod in upland pastures.

The tools of the sod cutter are few and simple, and any ordinarily intelligent laborer can cut good sod with proper instruction and a few days' practice. The best sod shovel is the one called a "moulder's shovel," a flat steel shovel, ten inches wide and twelve inches long, which retails at $1.25 each. These are thick on the edge when bought, and should be drawn out cold on an anvil, sharpened on a grindstone, and kept sharp by the frequent use of a flat smooth file. The shovel should be cleaned and wiped every night with an oily rag, and if it is left unused for any considerable time, should be hung up in a dry place and coated with grease, for it is essential to good work that the shovel should always be sharp and bright. A lawn rake should be used to rake the leaves and debris from the sod before it is cut, and if the grass is long it should be mowed with a scythe or mower.

In beginning operations the sod cutter marks off a line with the edge of his shovel, six to fifteen feet long, and another one the same length, parallel to it, at a distance of about twelve or fourteen inches. The lines are cut through the sod with the shovel held at an angle, and not perpendicularly, so that the roll is beveled at the edges, and when the sods are laid the edges slightly overlap This makes a better joint and keeps water from working under the sod and washing the bank. The lines being marked, the sod cutter holds his shovel nearly flat and thrusting it under the sod, cuts the roll loose from the side, the width of the roll being regulated largely by the length of the shovel. Then he makes a square cut at the end and rolls the sod up, pulling out any weeds he encounters and cutting the roll off when it reaches a convenient size. Such a roll is generally called a yard, and is supposed to be a foot wide and nine feet long, but the usual size is about fourteen inches and seven to eight feet long, or slightly less than a yard. (One hundred of these rolls is a good wagon load, eighty being about the usual load.) The sod cutter, now having an opening, continues his cutting, taking care always to bevel his rolls in the same direction and to roll from the same end, relative to the bevel, so that the rolls when laid will overlap properly. It is but seldom that sod can be cut continously from an area larger than one or two hundred feet square Weedy patches come in, swales are encountered, or for some other reason the good sod runs out and another patch must be opened. Machines drawn by a horse are advertised as economical sod cutters, but the writer has never seen them used, and is inclined to doubt their practicability on account of the necessity of continually shifting the working place, as noted above.

Sod should be cut as thin as possible, say 1½ to 2 ins. thick. This has several advantages: the sod rolls better, and more can be carried in a wagon load, but chiefly such sod laid on a bank, quickly sends out fibrous roots from the cleanly severed ends of the old ones, and takes such a hold that in a few weeks it is an integral part of the bank and can neither be pulled nor washed loose. Sod cut thick, with the idea of saving all the roots, on the contrary never unites with the bank, and in some heavy rain, perhaps months later, the water works under it and the whole mass slides to ruin. Cutting the sod thin has the further advantage, if appearances are a consideration, that the roots remaining in the ground sprout again; and if the season is favorable and a little grass seed is sown, the unsightly scar disappears in a few weeks under a fresh growth of grass.

It was necessary this spring to remove some sod laid about a year ago in one of our parks, and for experiment the rolls were cut at right angles to the direction in which they had been laid. It was found impossible to detect the seams, as the roots had knitted together into a homogeneous mass, and the rolls held together as well as any freshly cut sod.

The bank should be graded and smoothed preparatory to the laying of the sod, and if the soil is very hard and sun-baked, as the banks of a cut in clay soil are apt to be, it should be sprinkled and the surface loosened with a garden rake. The sod is unloaded at the top of the bank, and the rolls laid beginning at the top and unrolling down hill, taking care to have the bevels overlap as previously explained. If a road or gutter is at the bottom of the bank as is frequently the case, it is a good plan to run a roll of sod horizontally along it, and to make the joint of the ends of the vertical rolls with this, instead of the gutter direct, as this makes a neater job. Sods are cut to fit and joints made with an old butcher knife, and all holes are filled with the scraps cut off, pounded down with the fist. Fine dirt should be sifted into any cracks between the rolls.

After the bank is covered with sod, it should be thoroughly soaked, except in the early spring when showers are frequent. An ordinary street sprinkler may be used for this, but a better plan is to use a 500-gallon steel wagon tank, with 50 ft. of 2-in. hose fitted with a large copper rose nozzle. By driving this along the top of the bank, every portion of a slope of ordinary size can be reached.

After this the sod must be tamped firmly in place to expel the air under it and to insure a quick union of the roots with the soil below. Generally a roller cannot be used and iron tampers are ineffectual and awkward to use on a slope, so we generally use a tool called a "spatter." This is simply a piece of 2 or 3-in. oak plank 10 ins. wide and 18 ins. long, strengthened by cleats nailed across the ends, and with a round elm, sassafras or other tough wood handle, 2 ins. in diameter and 4 ft. long, one end bevelled off and bolted lengthways to the plank with two ⅜-in. carriage bolts, at such an angle that when the plank lies flat on the ground, the upper end of the handle is about the height of a man's waist. The heads of the bolts should be countersunk in the plank, and the edges chamfered off to avoid cutting the sod. A man swinging this spatter above his head can strike a much heavier blow than he can with a tamper with the handle fixed vertically, or with the back of his shovel, which is frequently used for want of a better tool.

If the weather is dry after the sod is laid, it must be watered two or three times a week until it starts to grow. A mere sprinkling will not do, but the sod must be soaked until the water penetrates clear through to the soil beneath. It is well also a week or two after the sod is laid, to go over the bank just after a heavy shower, and beat it all down again with the spatter. If the sod cannot be pulled loose by dragging at it with both hands, it is a pretty good indication that the roots have taken hold, and from that time on the sod will take care of itself.

Spring and fall are the best seasons to lay sod, but it can be done nearly every month in the year, except when the ground is frozen hard and the few hot and dry weeks in July or August, when the water used for sprinkling scalds the roots The writer has seen sod laid successfully in December when the rolls froze hard every night, and it was necessary to lay them in the sun till noon the next day before they were thawed sufficiently to unroll; and he recalls an instance when sod cut the preceding fall remained frozen all winter in the roll, and was laid and grew beautifully in the spring. The following details of cost are derived from the data obtained from laying about 20,000 sq. yds. of sod in Washington Park in the city of Springfield, Ill.:

| | |
|---|---|
| Cost of cutting | $0.016 per sq. yd. |
| " " hauling | .009 " " " |
| " " laying | .026 " " " |
| " " watering | .006 " " " |
| " " spatting | .001 " " " |
| Total cost | $0.058 per sq. yd. |

Men were paid $1.50 per day of eight hours, and the sod cutters had a theory very difficult to break up, that 75 "yards" or rolls cut should constitute a day's work. As in most public work the men were inclined to take it easy, and a contractor who could work longer hours and drive his men a little, could probably better these figures. It may be stated for purposes of comparison that sod contractors in this vicinity pay 1 ct. a sq. yd. for sod on the ground, and that 10 cts. a sq. yd. is the ordinary price charged for furnishing and laying sod complete.

TEN-WHEEL FOUR-CYLINDER compound locomotives on the DeGlehn system of compounding have been built for the Eastern Ry. of France by Schneider & Co., of Le Creusot, France. The first and second driving axles are operated by the inside low-pressure and outside high-pressure cylinders, respectively, and each cylinder has a slide-valve operated by its own valve gear of the Walschaert type. The high and low pressure gears are operated by different reach rods. The boiler has a Belpaire firebox and Serve ribbed tubes. The tender is small, and is carried on four wheels. The principal dimensions of the engines are as follows:

| | |
|---|---|
| Driving wheels | 5 ft. 8¾ ins. |
| Truck wheels | 3 " 0¼ " |
| Engine wheelbase | 26 " 9 " |
| Weight, empty | 61 tons |
| Weight in working order | 68 " |
| Cylinders ..... h. p...13¾×25¼ ins.; l. p...21¾×25¼ ins. | |
| Cylinders, c. to c. h. p.....7 ft. 1 in.; l. p...1 ft. 11¼ ins. | |
| Connecting rods h. p.....6 ft. 2¾ ins.; l. p...5 " 11 " | |
| Boiler, diameter | 4 " 11⅜ " |
| Tubes.....Number 130; diameter outside | 2¾ " |
| Tubes, length | 13 ft. 9¼ " |
| Heating surface, tubes (including ribs) | 2,126 sq. ft. |
| " " firebox | 141 " |
| " " total | 2,267 " |
| Grate surface | 33.3 " |
| Height, rail to top of chimney | 13 ft. 9¼ ins. |

TWO STEAM TURBINE TRANSATLANTIC STEAMERS have been contracted for by the Cunard Co., according to report. The ships will be built by John Brown & Co. and Swan & Hunter, of Wigham. While no exact figures are given out, it is said that these two new ships—the "Caronia" and "Carmania," are to be about 760 ft. long and 88 ft. beam, with an estimated displacement of about 32,000 tons. Three separate groups of cylindrical boilers will supply the steam; with forced draft and a coal consumption of about 1,000 tons per day. The turbines are not described; but the speed is to be not less than 23 knots, and the engines will probably approximate 70,000 HP.

AN ARC LAMP using magnetic or black oxide of iron instead of carbon for the positive electrode has been developed by Mr. Charles P. Steinmetz of the General Electric Co. The lamp gives a considerably higher efficiency in units of light produced in proportion to the current consumed than the carbon arc lamp and has a much longer life. An 8-in. electrode burns from 200 to 600 hours, so that the cost of attendance is very greatly reduced. In addition the light emitted is nearly pure white, and does not have the excessive amount of violet and ultra-violet rays of the ordinary arc lamp.

THE MINERAL PRODUCTION OF BRITISH COLUMbia for the year 1903 is given in the report of the provincial mineralogist, Mr. W. F. Robertson, as $17,495,954, showing a gain of $9,404 over 1902. Copper alone of the metals shows a material gain. Gold, silver, lead and coal all show a loss.

A SERIES OF ROCK DRILL TESTS is described in a paper read before the Mechanical Engineers' Association, an abstract of which appears in the Engineering and Mining Journal of May 12. The tests were made in South Africa. Vertical holes were drilled in granite blocks 2 ft. thick, a careful record being kept of the air consumption of each kind of drill. The lowest average air consumption, for a range of pressure, from 35 to 85 lbs. per sq. in., was 10.52 cu. ft. of free air per cu. in. of rock drilled, for a 1⅝-in. Slugger drill. One drill consumed as high as 21.52 cu. ft. of air per cu. in. drilled. As given in the abstract, the records do not state the length of each test, nor the diameter of the bits, nor the depth of each hole—all being factors of the greatest importance. The wages of the drill crew are a more important item than the cost of power, hence the speed of drilling should have been stated. There are not to be found in print any reliable data as to the effect of diameter of hole upon speed of drilling with power drills, hence the cubic inch of rock drilled means little or nothing. Finally a power drill that is very effective with a drill only 2 ft. long, may prove quite ineffective when the weight of steel to be lifted is several times greater. Careful tests of drill efficiencies are much to be desired, but, unless they show more than these tests do, they add little to our stock of knowledge.

WELSBACH MANTLE STREET LAMPS are to be substituted for open flame gas burners throughout the boroughs of Manhattan and Brooklyn, New York City, if the recommendations of Commissioner Oakley of the Department of Water Supply, Gas and Electricity are carried out. At present the City of New York uses from 5,000 to 6,000 mantle gas lamps and about 19,000 flat flame burners. The latter are of about 12 c. p., while the mantle burners give about 60 c. p.

# ENGINEERING NEWS

**A Journal of Civil, Mechanical, Mining and Electrical Engineering.**

*Entered at the New York Post-Office as Second-Class Matter.*
*Published every Thursday*
*at St. Paul Building, 220 Broadway, New York, by*

*THE ENGINEERING NEWS PUBLISHING CO.*

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE, 31 Rue de Faubourg Montmartre, PARIS.

*SUBSCRIPTION RATES: United States, Canada and Mexico, One Year,* $5.00; *6 months,* $2.50; *10 weeks,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $8.00; *Thin Paper Edition, One Year,* $6.75. *SINGLE COPIES of any number in current Volume,* 15 *cents.*

*In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 325 means that subscription is paid to the 32d week (that is the issue of Aug. 10) of the year* 1905; *the change of these figures is the only receipt, unless one is sent by special request.*

*ADVERTISING RATES:* 20 *cents a line. "Want" and "For Sale" notices, special rates, see pages 26-27. New copy for standing advertisements should be received ten days in advance of publication; new advertisements, Monday morning. The pages containing "Want" advertisements are held open until Tuesday, and those with "Proposal" and "For Sale" advertisements until Wednesday at* 11 *a. m.*


A correspondent in another column suggests that lack of executive ability is a common failing among engineers, and thinks that the remedy might be found by training the executive faculty in the engineering schools. We agree that whatever can be done in this field is well worth doing; but we are inclined to the belief that very little of real importance can be accomplished.

The average student in an engineering school spends there the years from 18 to 22 and at that period of his life he is too immature and too uncertain of his own ground to develop any large amount of executive ability. It is the education that he receives in the ten years after graduation which will develop or suppress whatever latent powers of executive ability he may possess. It is a fact to be deplored that many young engineers who have the natural ability to discharge large responsibilities are placed by circumstances beyond their own control in positions where their powers of leadership and of self-reliance become atrophied through disuse.

There is a general well-founded complaint of the scarcity of men who combine technical knowledge with the push, resourcefulness and self-reliance of the independent man of business. From other sources come complaints of the scarcity of competent foremen in the shop and in the field. But let those who make these complaints stop and inquire what means they have taken to develop such men among their own employees. The man who has never done anything but carry out detailed orders of a chief has not had the proper training to go ahead on his own responsibility.

It is not on such a basis that great industries and great business organizations are built up. It was Mr. Carnegie's young partners, as Mr. Carnegie himself frequently said, that built up the Carnegie Steel Co. His was the task merely to choose the men fit to bear responsibility and give them a free rein.

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The relative merits of concrete and of burned clay tile or terra cotta as fire-resisting materials have been a subject of dispute for a dozen years. As a result, the rival interests concerned have drawn together in two bodies on opposite sides of the median line of temperate discourse and the venturesome one who gets between is impaled both front and rear. We do not at present propose to assume this hazardous position, but from a safe distance will direct attention to the report by Prof. C. L. Norton and Joseph P. Gray, both engineers of the Insurance Engineering Experimental Station at Boston, which we print nearly in full elsewhere in this issue. Both of these well-known experts in fire insurance engineering take a square stand in this report in favor of the superiority of concrete as a fire-resisting material for protecting the steelwork of skeleton buildings. With this stand we propose neither to agree or disagree at present, but there are two lines of argument made to which attention can well be directed. The advocates of tile fireproofing have often asserted that concrete was an inferior material, because, first, of the difficulty of getting it properly proportioned, mixed and placed in position; and, second, because it is a crystalized product when hardened, and, therefore, will disintegrate when the water of crystalization is driven off by intense heat. To these two claims Messrs. Norton and Gray devote special attention in their report and engineers will do well to read and mark closely what they say. The discussion is brief and clear, and it is unnecessary to repeat it here, but it may be well to mention that one of the most frequent comments in the various accounts of the Baltimore and Rochester fires has been that pointing out the need of better workmanship in tile fireproofing work, while one competent observer at least has advised that concrete fireproofing be given increased section to allow for surface disintegration in case of fire.

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The reconstruction of Baltimore's burned district so far as it has yet been planned and carried out is described in another column of this issue. It will be agreed, we think, that high praise is due to the Citizens' Emergency Committee, to the Burnt District Commission, and to the city officials who have co-operated with these bodies, for the thoughtful and complete plan of improvement that has been suggested. The works that have been planned, if they are carried out, will make a new city of Baltimore, so far as its business section is concerned. Its narrow and hilly streets will be widened and leveled; its harbor works will be systematized and built up on modern lines; it will be provided with a system of sewers, something it has never had; its building regulations will be revised and bettered; wires will be put underground, and a multitude of minor and much-needed improvements will be inaugurated. To institute such a list of improvements would be a noble work for the wealth of any city and for a city staggering under a property and business loss of more than a hundred million dollars to have instituted them is truly a magnificent work. With all this the city of Baltimore is confronted with the unfortunate possibility of seeing its opportunity for increased municipal greatness come to naught. As is pointed out in the article mentioned, the City Council on whose shoulders falls the duty of executing the plans has failed so far to carry out the work in the thorough and liberal spirit in which it was conceived. Every detail of the improvements that has come before the Council for action has been rejected or altered out of all semblance to its original form. To what length this policy will be continued is uncertain. It hardly seems likely that it will be carried far enough to reject entirely the proposed plans, but it may easily be carried far enough to nullify to a great degree the benefits which these plans now promise to the future Baltimore. This would be most unfortunate. It is now that the city's narrow and congested streets should be widened and straightened if they are ever to be; it is now, if ever, that its business section should be built up with such fire-resisting structures as will make disaster by fire impossible. The citizens of Baltimore should force these truths home to the minds of their lawmakers with hammer blows.

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As a result of experience in the Baltimore and the Toronto fires, dynamite as a means for checking the spread of conflagration will probably occupy a less prominent position in the future in the minds of heads of fire departments than it has in the past. The razing of buildings by dynamite while always ranking as the last ruthless resort has been generally regarded as being reasonably effective as a fire stop. The experience in dynamiting buildings, both at Baltimore and at Toronto, indicate, however, that it is not only a useless procedure but a positively dangerous one. In both cities the effect of the explosions on the ruined buildings was simply to produce a heap of wreckage which could not be mounted by the firemen and which was scarcely less combustible than the original building, while the gap placed in the path of the flames was so narrow that it was easily leaped by the fire. The effect on the surrounding buildings, which it was the purpose of the explosion to protect, was to smash in the windows and thus destroy the only barrier that existed against the immediate penetration of the flames to the interior combustible finish and contents. In the case of some of the fireproof buildings at Baltimore there seems reason to believe that a considerable part of the damages to the walls and to the structural fireproofing was caused by the violent shocks produced in dynamiting adjacent structures. However this may be, it is certain that in many cases the dynamiting was delayed until the "mined" building was ablaze, with the very natural result that burning brands and debris were actually hurled through broken window openings into neighboring buildings. Such happenings as this are of course chargeable solely to unwise direction of the work, but they are certain to occur in the excitement and panic of a losing battle against a conflagration. At best, dynamiting is a dangerous and uncertain means of fighting fire unless it has been much maligned by the experience at Baltimore and Toronto, and heads of fire departments will act wisely if they strike it off their list of fire fighting methods.

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A commendable step has been taken by New Jersey in requiring candidates for the position of Sanitary Inspector or Health Officer in any municipality to pass an examination and receive a certificate from the State Board of Health. The first examination under the new law is held this week. The subjects for examination include the health laws of New Jersey, preventable diseases, isolation and quarantine, disinfection, nuisances, collection and disposal of refuse, vital statistics, &c.

While no very high standard of qualifications is likely to be required at the start, it is a great step in advance to have the assurance that Health Inspectors hereafter will possess at least some technical knowledge regarding the duties of their office.

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The committee on graduation requirements of the Society for the Promotion of Engineering Education is making an investigation of the question: "What ground ought a student to cover to entitle him, first, to bachelor's degree in engineering, such as B. S. or Ph. B., and, second, to a professional degree, such as C. E. or M. E?" To facilitate its inquiries it has prepared and is sending out a blank covering practically all branches of study pursued in professional schools and it is distributing this blank among teachers of engineering requesting them to mark each subject that they think should be made obligatory for the granting of a degree together with the number of hours which should be devoted to it in the way of study, recitation and shop or field practice.

One thing is very evident to the candid observer who studies this blank: The number of subjects whose study is being undertaken in engineering schools nowadays is so great that we must make a choice between a broad and general engineering education and a specialized one. If we choose the broad and general course we must avoid the danger of teaching a smattering only of a great many things. If we choose the specialized course we must take care that the student does not devote so much time to his specialty of, let us say, metallurgy for example, that he will neglect the broad foundation studies, which must be thoroughly mastered by the student in any course, if he is to have any rightful claim to a degree at graduation.

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Supplementing the extended paper by Mr. Jas. O. Handy on the art of water softening in our last issue, we print this week an extract from a recent paper before the Institution of Mechanical

Engineers describing English practice in the same field. It will be noticed that the author agrees with Mr. Handy in his statement of the chief difficulties encountered in the operation of water softening plants.

One matter discussed in this English paper is of especial interest in connection with the use of hard waters for steam boiler plants. We refer to the use of water softeners to remove grease from feed water where the water is to be used over and over again. As many of our readers may recall, this subject has been previously discussed in these columns in connection with tests made at a Detroit electric light station, described in our issue of March 20, 1902, where the only effective method found for the removal of grease was the mixing with the greasy water of water containing lime carbonate in suspension.

A correspondent in this issue calls attention to the serious objections to a hard water supply on the part of steam users and he does not at all overstate the case. It is entirely true that many of the waters met with in the West and South are almost impossible of use in steam boilers if handled in the ordinary manner. But in all such cases the proper course to pursue is to arrange the steam plant to use the same water over and over again by the provision of a cooling tower and to soften the water used to make up the loss by evaporation and at one operation remove the precipitated lime and the grease which otherwise forms such an obstacle to the repeated use of water in a steam plant.

The gains in such a plant are a higher fuel economy, due to the fact that engines may run condensing, a large saving in the cost of water supply, and decreased expense in the care of boilers due to the use of water free from grease and scale-forming impurities for their supply.

## SHOULD CIVIL ENGINEERING SCHOOLS BE MODELED AFTER WEST POINT?

Whenever the suggestion is made that engineering students should be given courses in this or that new subject, the reply that comes quickest to the tongue is to the effect that already more subjects are taught than can be mastered by the average student in four years' time. Then a counter question is asked: What would you drop from the present courses to make room for your proposed course? The question is not an easy one to answer, but as engineering education is a subject of perennial interest to the old engineer as well as to the young, an attempted answer to this hypothetical question will be made.

That the four years of work in the average engineering college are years already crowded with subjects is manifest by a casual examination of catalogues, and when we come to inquire as to the hours of time that each instructor expects his students to devote daily to each subject, we are more than ever impressed with the fact that the students are "filled to the brim" with work.

A senior in one of the large engineering colleges recently told the writer that at the first of each year it had been his custom to go to each of the professors and instructors with this question: How many hours should I devote each week to each subject that you teach? Having thus received an estimate from the men best able to judge the time required to do justice to the respective subjects, he found that upon adding all the estimated hours together and dividing by seven, he had about thirty-five hours left for sleep and recreation during the week! This did not happen one year, but every year of the four. Needless to add, the student decided not to "do justice" to every subject.

If this condition of affairs is at all common, and we believe it is, what does it indicate? Unquestionably it points to absence of true leadership in arranging the courses of instruction. It indicates that the head of each department strives to force into the curriculum as much as possible of his own particular subjects, in a measure acting regardless of the work laid out by the heads of other departments. The result is that the most forceful instructors, and particularly those who are most severe in "marking" examination papers, crowd subjects others than their own into the background.

A professor who is "strong" in bridge engineering, makes bridge designing the feature of the college course. To him engineering unconsciously has become a term synonymous with strains and stresses in framed structures. His every effort is devoted to graduating men who will be a credit to him by virtue of their ability to assume responsible positions as bridge designers shortly after graduation. Numerous problems are given each week to the students, and the number of these problems is so great that but two lines of action remain open for the student. Either he must neglect other subjects, or get the solution of each problem from students who have neglected every other course of instruction.

It is well known to engineering graduates that one college makes a feature of bridge problems, another of railway problems, another of masonry construction, and so on. When one comes to look into the cause of this onesidedness, the reason is apparent, the cause being, as we have said, the lack of broad leadership in the person of the dean or president.

We may hear it urged that such leadership, while perhaps desirable, is not to be had as a rule so long as it remains a trait of human nature to enjoy doing most that which is done best. Each professor must be more or less one-sided in his experience and in his natural aptitude for doing certain kinds of engineering work, and being so he will unconsciously strive to mold the students as he himself is molded. If the president or dean is himself an engineer, and if he is a forceful man, then, it will be urged, he will force upon the college his own specialties, more or less to the exclusion of others. If he is not an engineer, then he will not be able wisely to map out any course, to say nothing of co-ordinating all the courses wisely.

As a solution of this difficult problem, there seems no better way than the organization of what might be termed "a board of strategy," representation on this board being given to every department of instruction in the college. Perhaps even a better plan would be the organization of such a board upon which the acknowledged leaders in every engineering college would have a place, as well as the acknowledged leaders in the different branches of those practicing the civil engineering profession. There has been an encyclopedia of literature written upon the subject of engineering education, and the result has been to bring engineers together on at least one point, namely, the wisdom of teaching only the fundamental principles of engineering science, leaving to subsequent years in the school of experience much that is now taught at college. Furthermore, the verdict has been against specialization in engineering colleges, so that nearly all engineers composing such a board of educational strategy can begin their work holding fundamental opinions in common.

We have had much talk, let us now have a little concerted action. Our theories have been elaborated, now let the rules of practice be formulated. If a few engineers still urge specialization, let them apply their theories to West Point—an engineering college that, while professedly military, has graduated scores of the most noted men in the civil engineering profession. In West Point they will see a refutation of all arguments in favor of specialization in civil engineering colleges. Moreover, they will find in West Point a model well worthy of consideration in virtue of what is not taught there. They will not find students there spending several hours a day, for several weeks, working on problems in chimney design, as is the case at one of our engineering colleges. They will not find students working in a similar manner testing innumerable samples of concrete, as at another college. They will not find students bending over drawing boards for weeks designing every type of bridge truss and every detail of every type, as at still another college. What they will find is: first, co-ordination of the courses, so as to give to each subject its due apportionment of time; second, disciplinary training that tends to make leaders of men; third, physical training that insures a long life of usefulness; fourth, moral training, that puts honor above every other consideration in life.

There are, it is true, several courses of instruction at West Point which may well be omitted from any purely civil engineering course; but for them should be substituted a training in engineering economics, which appears to have been but slightly touched upon. The military engineer is far less concerned with the cost of structures than with their serviceability for the purpose at hand; but in the mind of the young civil engineer the word cost should be printed in large letters. As a part of certain other courses the dollars and cents faculty of the young engineer can be cultivated, instead of being left as it now is to "soak in" after graduation.

The late A. M. Wellington, in editorially discussing engineering schools in these columns some years ago, laid great stress upon the advisability of conducting summer schools of surveying just as railway surveys are conducted, giving command of parties to the students in turn, for the purpose of teaching obedience to orders as well as for the purpose of cultivating the faculty of leadership. There is much in this suggestion that merits consideration. Indeed, it would be a carrying out of the West Point method of organization and discipline in a way that should prove of inestimable value.

The summer schools, moreover, possess a feature that is seldom emphasized enough by educators. We refer to the concentration of attention upon one subject at a time. It seems to be a trait of the human mind that it does its best work, not by intermittent effort, however regularly repeated, but by concentration of effort upon one subject, the only pauses being for physical exercise and recreation. The great inventions are not made by intermittent attention to a dozen projects every day, but by thinking on just one project at a time, day in and day out, resting the mind only by recreation and by sleep. This trait, it seems to us, explains the remarkable progress made by students of surveying in the summer schools; and it is deserving of careful consideration in mapping out any course of mental training.

To sum up we may say: The students of engineering colleges are, as a rule, left too much to act as suggested by their own immature judgment, or forced by fear of failure in examinations to devote hours to one subject and minutes to another, regardless of the actual value of the subjects. The time has come when educators are agreed upon the wisdom of teaching general principles, upon the wisdom of training, rather than cramming the mind, and upon the wisdom of caring for the moral and physical welfare of the student. It still remains to put these theories into practice, as has been done at only one college of engineering, and that one, strangely enough, the oldest and the most celebrated in the land—West Point.

## LETTERS TO THE EDITOR.

### The Abilene, Texas, Water Tower Failure.

Sir: In regard to the Abilene, Texas, tank and tower failure, from the architects' drawings it will be seen that there was no provision made for plumbing the structure, since all diagonal braces were composed of solid members riveted to solid connections. In erecting structures of this kind unless extreme care is exercised the structure is liable to become "spiraled," caused by the slack in the bolts used to assemble the members during erection. The details show but two units in each diagonal connection, which gives a great opportunity for a slight movement to take place at the connections while riveting up and removing bolts. A better diagonal to have used would be a pin-connected rod with turnbuckle.

In view of the fact that the columns were very unequally loaded, it is probable that a greater settlement took place in the foundations of columns B than in columns A, thereby throwing considerable strain upon the diagonals, which would be first to give way, leaving column B practically unsupported for its entire length, thereby causing the tank to drop almost vertically.

The design of the bottom is also very faulty, an excess of material being used. A much better construction is secured by the use of the hemispherical bottom, such as is used in the elevated tank at the Iowa State College, Ames, Iowa, which was illustrated in Engineering News of Jan. 2, 1902.

It is to be regretted that many so-called architects and engineers undertake the execution of work of which they have but little knowledge, nor do they seek the advice of those who are in position to render them valuable assistance, preferring rather to "go it blind" or use some "rule of thumb," as seems to have been done in this case.

Much more might be said in just criticism of the whole design of both tank and tower, and especially the specifications. Respectfully yours, S. F. Moeller.
Engineer for Moeller Bros., General Contractors.
Knierim, Iowa, May 23, 1904.

### Making Concrete Water Tight.

Sir: We have read the article in your issue of May 19, "Making Concrete Water Tight," and desire to call your attention to some statements therein which are scarcely correct. The reader would infer that Bermudez and Alcatraz Lake asphalt and asbestos felt were the materials generally used for such purposes, whereas the facts in the case are as follows:

Prior to the building of the New York Subway, cellars and foundation walls have been waterproofed in this city for many years by men who make a regular business of it. The standard material for such work is coal tar pitch and tarred felt. The use of asphalt and asbestos felt for this purpose is comparatively new and untried. The foundation walls and basements of practically all the modern buildings in this city are waterproofed with coal tar pitch and felt. A striking illustration of the permanency of these materials was shown a few weeks ago in tearing out a portion of the old Park Ave. tunnel, north of the Grand Central Station, where the new terminal improvements are going on. This waterproofing of coal tar pitch and tarred felt was laid 32 years ago, using less material and less skill than is employed in similar work by contractors who now make a specialty of waterproofing, and a careful examination of this 32-year-old waterproofing work shows the coal tar pitch and felt to be absolutely unchanged. In your article referred to, where you speak of Bermudez and Alcatraz waterproofing, you also state "its ultimate durability is unknown." The ultimate durability of coal tar pitch and felt is known, and should be of interest to your readers.

You also call attention in a foot reference to a specification for asphalt mastic on government work. Permit us to state in this connection that the Navy Department erected a pumping station for the dry-dock in the Portsmouth, N. H., Navy Yard in 1902, where the specifications called for 6 ins. of asphalt concrete or mastic for waterproofing. Experienced contractors for such work who were consulted declined to undertake it as specified and guarantee the results, but the contract was eventually awarded to the Tuttle Roofing Co., of this city, who carried it out successfully, using coal tar pitch and tarred felt in alternate layers, and overcoming a water pressure of 44 ft. Plain, straight-run coal tar pitch is absolutely unaffected by water, hence its great permanency for this purpose. Yours very truly, Barrett Mfg. Co.,
M. Childs, Vice-President.
17 Battery Place, New York City, May 23, 1904.

### Experience in the Use of Compressed Air Ejectors.

Sir: Having charge of a large air plant, I noted with interest a recent article in your editorial columns in regard to air supply for forges from a compressed-air plant of high pressure, and although I am without data of any value, I do not accept as proven that a jet of compressed air impinging on the back of the blades of a fan, will deliver a larger volume of air at a suitable pressure than if used in what you term an ejector.

If I understand your term, an ejector is a jet of high pressure air through an opening of considerably greater area, by which means a large volume of atmospheric air is induced, mixed and discharged with, the jet. I have looked in vain for any reliable data regarding volume and pressure under these conditions, but have had in use for nearly a year a device of this kind; that, with less than 7 cu. ft. of air (by table in Hiscox's "Compressed Air") at 100 lbs. pressure, operates rivet forges much more satisfactorily than was previously done with a direct blast of compressed air from which the atmosphere was excluded. I have had another device (maker unknown) which admitted compressed air through an annular opening around a tube about ⅝ in. diameter. This gave a pretty high pressure but was deficient in volume for the required purpose. The ejector blowers which I now use have a nozzle opening made with a No. 52 twist drill, flared slightly at the outer end and discharging into a hollow frustum with an opening 1¼ ins. in diameter at the small end: the end of the nozzle being about 3 ins. back from the opening and in line with the center.

I have found that a straight tube extending 3 or 4 ins. from, and of the same diameter as, the small end of the frustum, increases the efficiency, but have not been able to determine to what extent.

I have recently by another device applied to heavy forges, raised to a welding heat a bar of 4 in. iron in less than 18 minutes, with an estimated expenditure of 38 ft. of air per minute at 100 lbs. (by table as before). I have not applied such a device behind the blades of a fan, though if that should be done, and the fan then takes in air, it would certainly go far toward proving the efficacy of an air jet applied in that way; but the result of such few experiments as I have been able to make, inclines me to the belief that more can be obtained from compressed air by induction than by actuating machinery with it for the purpose under discussion.

I have found that very slight differences of size and form make wide differences in the results, and estimating consumption from tables and formulae is quite another matter from measuring actual volumes. I would like to know if any of your correspondents have any reliable means of measuring air volumes at or near atmospheric pressure, at a reasonable cost.

My experiments show that the induction of air is a wide and promising field for investigation, and I believe in the possibility of valuable devices for producing lower pressures by other means than reducing valves, in which the difference of pressure is a dead loss.

Sand blasts, pneumatic painting machines, and other devices of that class ought to be operated in such a way as to return at least a portion of the surplus energy by inducing air at the required pressures, and may it not be possible that stored pneumatic power at higher pressures would yield greater efficiency if handled in the same manner. Yours respectfully,
Edmund Hoxie,
78 Clinton St., Everett, Mass, May 16, 1904.

### The Development of Executive Ability in Engineers.

Sir: Referring to your editorial on "The Demand for Engineers of Business Ability" appearing in the issue of May 5: Will you kindly permit me to ask a pertinent question? What salary does the "Assistant Engineer of the Pennsylvania Railroad" and "other sources" offer "engineers"?

The commercial engineers to-day are so scarce that the prevailing salaries paid by railroad corporations have allowed them to be practically all picked up by up-to-date contractors, and if contractors do not bid for the man who has executive ability, he is enterprising enough to place himself on a market where he will command a salary in proportion to his ability.

The schooling that young men receive from our universities and the class of work they usually all go, or seek to go, into, immediately upon graduating, are generally not of a nature to awaken their executive ability, and it is often not until after years of business life that they realize their own possibilities.

Too often graduates enter the employ of men who are accredited engineers, but who lack the breadth of mind that marks the truly executive engineer. Such men do not trust their subordinates to assume responsibility, even in the smallest detail, consequently a man soon ceases to depend on his own recourses and looks to someone else for all guidance. Different tactics on the part of his employer would completely reverse the young man's character, for there are very few American boys of to-day who cannot take the initiative when it is necessary.

I recently employed a young man, graduated from one of our leading technical schools, who had been in the office of the Chief Engineer of a prominent railroad for five years; I asked him to make a survey, locating a portion of a canal, using a railroad tangent as his base line, and was dumbfounded to have him ask, "How do you want it done?" And I know an astonishing number of this class of graduates.

Is not this a subject that might advantageously be brought before our universities? It becomes more apparent every day that a man who knows only calculus, surveying, and the theory of masonry, is not the engineer we need. Why should not our schools take it upon themselves, as a part of the curriculum, to impress upon the students the fact that a knowledge of bridge strains will not build a bridge, but that it requires executive ability of a high order, to handle men and material to accomplish the desired results economically.

The average young man in going through school, if he has been at all enterprising, will have seen, heard, and studied so many different subjects that but a fleeting impression of them remains with him, which makes it difficult for him to choose what particular line to follow.

Why not teach him executive ability? It can be done.

I have recently been handling quite a large corps of men, all college graduates, some having graduated several years ago, and at first they exhibited very little, if any, executive ability, but still retained the ideas formed in the class room. After a careful study of each man, I determined to try teaching them to realize the importance of using their time and material to the best advantage, and gave them to understand that I would hold them responsible for their work. Personally, they did not know what I was attempting, but the result of one month's effort was astonishing; it made them fully twice as valuable to me; but after such training it is hard to hold them, as contractors will pay men of this class higher salaries than railroad corporations usually do.

Yours truly, R. R. Engineer.
May 13, 1904.

### Engineers' Fees and the Close Profession Plan.

Sir: In the last issue of your valuable paper, under the caption of "Letters to the Editor," I read with interest the article signed "Practitioner," concerning the "Basis for Engineering Fees."

Prices ranging from $100 to $1,500 were, in this case, received by a certain town as bids from [illegible] relative to the fee for furnishing plans [illegible] for a proposed water supply, the estimated cost of which was $23,000.

This certainly shows a wide range of [illegible] among engineers as to the value of their services, and it is no wonder that "Practitioner" is anxious to know upon what basis these values are computed.

It is in the *utter absence of this basis* [illegible] in instances, as the one in question arise. The old [illegible] "the workman is worthy of his hire" holds good [illegible] the "trades" to a certain extent. In law and medicine the fees are regulated by the protection which these [illegible] professions receive from the state and no question is raised, as to what we must pay our doctor or lawyer. But in the profession of engineering, the state has never deemed it of sufficient importance to regulate in any manner, who shall be allowed to practice and as to fees, in engineering, the word fee is entirely forgotten. The question naturally arises, what is the remedy?

It is not that we have too few technical colleges where young men can receive the best products of the best minds on engineering subjects and thereby lay a firm foundation upon which to build a lasting and effective engineering experience.

Thousands of bright young men receive their degree in engineering each year. They enter the profession and what do they find? If they enter into active practice, the experience of "Practitioner" is immediately presented, they lose heart and say, what is the use of spending good money and time in learning a profession if the educated and trained man is to be on the same basis as the inexperienced.

The trained man cannot in justice to himself, compete with such men, in the matter of fees, and he simply "quits" and the profession is losing good men each day and their places are being taken by the inexperienced and self-styled engineers.

Here is a case in hand: When I was chief engineer of a certain coal company, two young men, having completed the course furnished by the public schools of a small town, entered the office as chainmen. After 1½ years of training in that office, they were, in their minds, "full-fledged engineers." Their fathers, thinking their illustrious sons were simply wasting time, presented them with the necessary certificate to enter the practice of engineering; viz., a check covering the cost of a surveying outfit.

These two young men are now practicing and are known to the public as civil and mining engineers. Think of it! One and one-half years in an engineering office, doing nothing but simple surveying, having no experience save that afforded in the "mine survey corps," are now civil and mining engineers, and the public believes it and gives them work to perform. Again I ask, what is the remedy? What is to become of the engineering profession if this is to continue?

About ten years ago, a petition was placed before the State Legislature of Pennsylvania, the gist of which was as follows:

Any person desiring to enter the practice of engineering must show a diploma from a college of recognized technical standing.

It went to the legislature but was not passed. Its opponents argued in this way: We have many engineers who have not had the good fortune to attend the technical school, but have gained much from the school of experience and are bright and shining lights in the profession. Such a law as is here proposed would not only deprive us of good men, but would take away their liberties, which we cannot do.

They are undoubtedly correct in that treatment of the subject. To say that a man must make himself proficient in engineering by technical training alone, would be to my mind unjust. But to compel a man to get it and prove that he has it, is, I think, the true plan to pursue. Let us have a state board of examiners, composed of practical and experienced engineers and before a person can practice engineering, he must receive a certificate from this board. I think this will make us all show our true colors and thereby greatly elevate the profession of engineering.

I shall be greatly pleased to hear the views of others on this subject. I fervently believe if the American Society of Civil Engineers would present this matter to the members of the legislature of each and every state, it would be sowing seed on good ground and be an initial movement in the right direction.

The Government of Canada has progressed far beyond us in the protection of engineers in this particular and I see no reason why our government should not do the same. Yours very respectfully,
C. P. Collins.
Johnstown, Pa., May 20, 1904.

### Concerning Underground Waters as Sources for City Supply.

Sir: An editorial which appeared in Engineering News of May 12, 1904, calls attention to the desirability of investigating underground waters for the purpose of determining their availability for use as sources of city

supply. It was stated that such supplies are particularly well adapted for municipalities of moderate size, *especially in the West and South*, where it is impossible to secure an unpolluted surface supply.

The announcement, appearing as it does without qualification, seems to be somewhat unfortunate in view of the fact that the situation, particularly in the South and West, is generally misunderstood. Coming as it does from an authoritative source, it must inevitably give fresh impetus to certain popular and erroneous ideas. One of the difficulties which the engineer is obliged to combat, especially in the above-named portions of the country, is the steadfast belief that a ground water supply is the panacea for all water department ills. The notion as it is usually given utterance cannot fail to be attractive to the uninformed, and does not fail, at times, to deceive those whose training should teach them otherwise. It is plausible, for example, to argue that because one driven well affords a certain quantity of water, nine more wells in the same region are all that are required to secure ten times that amount, and as it comes from subterranean sources, it must needs run on eternally, never failing in its capacity and pure and desirable in quality.

The history of underground supplies in the United States is not reassuring. In spite of brilliant initial promises, it has been found in the majority of cases that after a time the subterranean basin can be exhausted even as truly as can the old rain barrel at the back of the farm house, and this even when the draught upon it has not increased. There are, indeed, notable exceptions, but they merely serve to prove the rule. Time alone will demonstrate the persistence of ground supplies. There is a certain draft limit which is reached surprisingly soon, and at such a time the outlook to a growing city which has hopes and aspirations becomes dubious.

But it is not the quantity of water available which gives the most trouble. The question of quality is as pertinent as in the case of surface waters. This is especially true in the West and South. The desirability of a water for municipal use is not wholly based upon the presence or absence of matter dangerous to the public health. It is true that this is the standard which is in common use, but there are, nevertheless, other features nearly as important and far more difficult in their solution. A river water, polluted though it may be, can be made safe for domestic use. Nearly all the river waters of the United States may be used for industrial purposes. Except in a few comparatively limited areas, the deep well waters of the country are unfit for most industrial purposes, or may be used only after expensive treatment. A city with a bad boiler water will hardly prove prosperous unless there are great natural advantages which compensate. Certain classes of industries demand soft water, and the wise manufacturer will not locate a plant where such water is not supplied. A common inquiry among business men who propose to locate industrial plants in the West and South is, "Where may we find a town supplied with soft water?"

Among the recent examples which were brought to the attention of the author was a small city in the Middle West which had experienced considerable trouble from its river water supply. The difficulty arose solely from mismanagement of the filters. Confidence in filtration was sadly shaken, and there naturally followed a general demand for a ground water supply. The city has brilliant industrial prospects, and even at the present time the revenues from the unmetered factory service amount to $1,500 per year. Abundant evidence is at hand to show that the artesian water throughout the whole state is generally abominable for steam or manufacturing purposes. Its adoption would immediately result in a cut of $1,500 annually in water rents and make the place industrially unattractive for all time. In the opinion of the consulting engineer of this city, however, the only feature to be considered in connection with the successful establishment of an artesian water system are capacity and healthfulness.

Almost every railroad operating west of the Alleghenies has a history of severe losses due to hard water and its damage to boilers. One Southern road, and by no means the largest, has deemed it economical to appropriate $200,000 for water softeners rather than sustain losses resulting from bad waters which it is obliged to use along its right of way. Other roads, running west from Chicago, are dotted with these softeners costing from $2,000 to $10,000 each and operated at a cost of from two to fifteen times as much as cities usually pay to maintain filter plants. Such an expense is necessary in the case of railroads, for it is seldom that there can be, for them, a selection of waters. A supply must be had at certain intervals whether its quality be good or bad. Few cities cannot select a soft river water and purify it if necessary.

Therefore, in advocating the adoption of ground water supplies especial stress should be laid on the injunction to consider well the dissolved inorganic constituents and their economic importance. From the mass of evidence now at hand there can be only one deduction, viz.: the material prosperity of Southern and Western cities is largely dependent upon surface water supplies and efficient systems of purification. Very truly yours,

Marshall O. Leighton,
U. S. Geological Survey.

Washington, D. C., May 20, 1904.

(The foregoing letter was received too late for insertion in our last week's issue, but the editorial and paper of Mr. Handy in that issue constitute a very pertinent reply to the above letter, so far as a reply is needed. We fully agree that hard water is a serious drawback to any water supply, and that if the hardness cannot be removed, a surface supply, even one more or less polluted, may be the better choice. But with water-softening processes available for use, there are many places, we believe, which can make use of underground sources of supply to good advantage.

Of course the limitations to the quantity of underground supplies must be freely recognized, as well as the chances in some localities that they may have suffered pollution before passing underground. The decision, therefore, as to the best source of water supply for a particular community is one demanding expert knowledge. The public, as our correspondent says, is only too apt to fix on one thing or another as a panacea for all ills. It may be underground waters, it may be filtration, it may be sanitary protection of water sheds. It is the business of the expert engineer from his knowledge of the capabilities and limitations of all the systems to form an unbiased judgment as to what will best meet the local conditions and requirements.—Ed.)

## The Vacuum on the Face of an Overtopped Dam.

Sir: Referring to a discussion of the effect of partial vacuum between a sheet of overflowing water and the face of overtop dams, on page 450 of your issue of May 12, 1904, and continued on page 471 of your issue of May 19, 1904, permit me to say that the vacuum under dams is not quite so much a matter of theory as your correspondent in the issue of May 19 has seemed to assume. This matter was extensively considered by Bazin in his series of papers, "Recent Experiments on the Flow of Water Over Weirs," which may be found in Annales des Ponts et Chaussees, for the years 1888, 1890, 1891, 1894, 1896, 1898. The vacuum was also observed and commented upon in my paper "On the Flow of Water Over Dams," in Transactions of American Society of Civil Engineers, Vol. XLIV. (1900), pp. 220-398, inclusive.

The case cited by you in regard to a dam on the Quinebaug River, near Norwalk, Connecticut, is pertinent to the subject, although there is somewhat more definite information than this, both in Bazin's original paper and in my own paper, On the Flow Over Dams.

Yours truly, Geo. W. Rafter.

Rochester, N. Y., May 20, 1904.

Sir: I see in your issue of May 12, the question: "Is there a vacuum against the face of an over-topped dam?" In answer to that query I can say from my own experience that there is a partial vacuum, but of no very great amount; varying from nothing to one sufficient to support a column of water 14 ins. high between the face of the dam and the falling water.

I have observed, at a dam on the little Scioto River, near this city, having about a 12 ft. fall, the water being clear and only a thin sheet flowing over, the water behind the falling stream standing about 14 ins. above the level of the water below the dam. I have also noted the effect of breaking the sheet so as to admit air behind the falling water. The effect was to lower the water between the sheet and the dam in the immediate vicinity of the opening, but the effect of breaking the vacuum was not noticed farther than 15 ft. each way.

I have also observed at Millbrooke Park Lake, near this city, which has an overflow consisting of a series of steps of 18 ins. fall and 7 ft. tread. The upper or top step is finished very accurately to a perfectly level and smooth edge. I have noticed, with about 1-in. of water flowing, over that there was a partial vacuum, enough to support 4 ins. of water behind the sheet. This water did not stand at a uniform level, but was high in some places and low in others. Respectfully yours,

S. P. Baird, Assoc. Mem. Am. Soc. C. E.

Portsmouth, O., May 16, 1904.

Sir: Several letters to the editor in recent issues of Engineering News have touched upon the subject of the vacuum under the crest of overtopped dams. A record of what has been observed at three different dams, may be of value at this time to those interested.

At each of these three dams, the crest is level, the face so nearly vertical that the stream of water falls clear of it, and a small quantity of overflowing water forms a continuous sheet from wingwall to wingwall.

A view of one of these dams, not, however, with a flow of water over it, is to be seen opposite page 72 of the Journal of the New England Water-Works Association for March, 1904. Another of the three is of similar design and the same height, nearly 3 ft. The third is on a larger stream, has a longer crest and is about 6 ft. high.

At all times at these three dams, when there is a sheet of water flowing over them, there can be seen, as water can be seen in a glass bottle, a solid mass of water lying between the falling stream in front and the face of the dam.

No attempt has been made by the writer to measure its height. It can be seen that it is higher when the flowing stream is larger. In the case of the 6-ft. dam, it has been seen when it was more than 1 ft. above the bottom of the falling stream.

There must be other dams where the same phenomenon may be seen on a larger scale. The writer has not visited such places since it first came to his attention. It is hoped that others will observe and report.

Such occurrences seem to demonstrate the actual existence of an air pressure below the normal on the face of an overtopped dam.

Another occurrence that has been observed at the smaller of these dams (probably it occurs at the largest also) is that under certain conditions in the force and direction of the wind it acts upon the overflowing sheet of water, causing it to flutter or vibrate and produce a remarkable amount of noise.

These vibrations may be of the same nature as those that are recorded as produced at the first dam across the Connecticut River, at Holyoke, Mass.

Yours truly, Geo. E. Manning.

New London, Conn., May 19, 1904.

Sir: Referring to the recent discussion in your columns concerning the vacuum under the crest of overtopped dams and the statement that the vibrations set up in buildings at some distance from the dam were caused by vibrations of the sheet of water, which in their turn were due to the changes of air pressure between the water and the face of the dam:

Some observations which I made during the fall of 1901 and spring of 1902 at the mill dam across the mouth of the Licking River where it empties into the Muskingum at Zanesville, O., lead me to believe that the vibrations of the sheet of water are due to the natural law of liquids poured over a crest into free air, the same law or force which causes the contraction of a stream of water a short distance in front of the orifice through which it flows, or which causes a small stream of water poured from a pitcher to contract and expand in area and to finally break into drops before it reaches the ground. I have walked early in the morning over the celebrated concrete "Y" bridge at Zanesville which spans the Licking and Muskingum Rivers. Watching the sheet of water flowing over the Licking dam, one is struck by the appearance of horizontal bands of reflected sunlight playing down the face of the sheet of water, sometimes one band only, in case of a flood stage of water probably two to three ft. deep flowing over the crest and again a great number of bands when the sheet of water is thin. The number of bands of light which correspond to the number of contractions in sectional area of the sheet between crest and foot varied with the thickness of the sheet and they vibrated with increasing rapidity as the stage of water fell, being as low as 176 per minute for a 2 to 3-ft. depth over the crest and running as high as 1,000 to 1,100 for a thin sheet probably not over ⅛ to 1 in. thick, which broke into ripples or nearly separate drops before it reached the bottom. The horizontal bands of light extended in a straight line across breaks in the sheet caused by driftwood lodging on the crest of the dam, and were traceable as continuous horizontal lines when the thin sheet was broken from this cause and from minor inequalities of the crest into a great number of separate streams, varying in width from a few inches to 20 ft., separated by open spaces of as much as 5 ft. in width. This would indicate that the vibrations of the sheet of water are independent of an enclosed body of air in front of the dam. The vibration of doors and windows is only noticeable when the volume of water flowing over the crest is so large as to have a slow rate of vibration or variation of thickness of the sheet, which will harmonize with the natural period of vibration of the doors or windows. The impact of the varying quantity of water striking the bed of the stream sets the ground into vibratory motion, which is communicated through the ground to buildings, doors, windows, etc., whose natural rates of vibration are in harmony with the rate of variation in thickness of the falling sheet of water, which is in turn dependent on the depth of water flowing over the crest of the dam.

The variations in thickness of the sheet are not fixed waves. They fall with the sheet, but at a velocity apparently less than that of the falling water.

Hoping that this may throw some additional light on the subject, I am, Yours truly,

W. M. Dawley.

Youngstown, O., May 28, 1904.

## The Relation of the Character of the Asphalt to the Wearing Properties of an Asphalt Pavement.

Sir: During the last fifteen years the question of the relative merits for paving purposes of various asphalts has been actively discussed and with strong partisanship on all sides. It has recently appeared again in an article by Mr. Samuel Whinery, published in Engineering News of May 12, in which he notes that while sheet asphalt pavements take the first place in point of merit it is not a perfect pavement, owing to its high first cost and the

difficulties and expense that have been encountered in keeping it repaired. He then proceeds to discuss to what extent and in what way these objections can be obviated, especially as far as he believes that this can be corrected by the use of one or the abandonment of another variety of asphalt.

To several of his statements no exception can be taken and he is especially to be commended for his enunciation of the fact "that the first cost of any pavement is not a correct measure of its economy," and that "relatively high first cost is not a valid objection against any pavement, if it be demonstrated that it yields more and better service per dollar invested than other pavements." Of recent years there has been a strong effort made to reduce the price paid for asphalt pavements and the result has been the construction of asphalt surfaces on streets of heavy travel in a manner quite unsuited to withstand the conditions to be met. This is well illustrated in the city of New York, where, with one exception, Fifth Ave., the base supporting the wearing surface has not been sufficiently rigid to carry the traffic without vibration. The result has been a deterioration of the asphalt surface which has been attributed, more or less generally, to the character of the asphalt while the true cause, the lack of support of the surface by the base, has not been commented on. As a remedy for such defects the proposition has been made to use another asphalt as a cementing material in the surface mixture rather than a pavement constructed in this way will "yield more and better service per dollar invested than other pavements."

The base and binder courses of a pavement having been constructed in a way that is suitable to sustain the traffic to be carried by the pavement the question of the proper construction of the surface must be considered.

Mr. A. W. Dow, in a paper before the Society of Municipal Improvements, in 1898, wisely remarked:

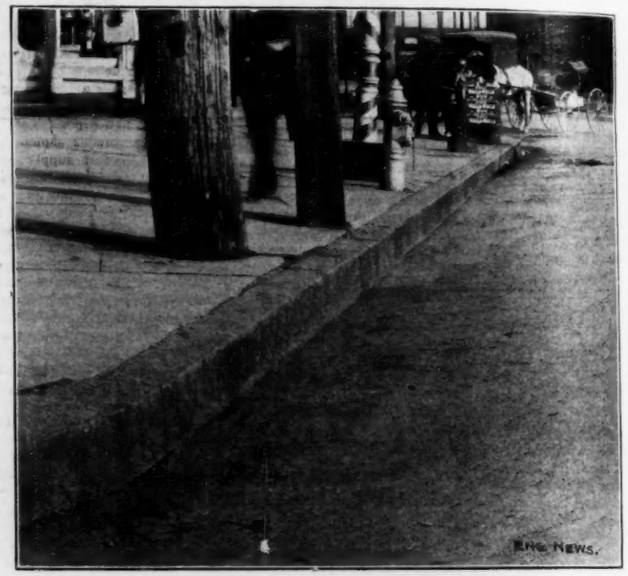
> As sand is 90% of the pavement, why should it not be the most important ingredient to consider; and, when a pavement is at fault, why should it not be more responsible than the asphalt which now bears the brunt of all failures?

As a matter of fact it is now pretty well known that even if all the other constituents of an asphalt surface mixture are of the best quality, the wearing surface will not prove a success unless the sand is suitable for the purpose.

In the early days of the industry, but little attention was given to the subject and the sand in use was whatever happened to be the most available at the particular locality where work was being done. Later, opinions varied as to whether a coarse or a fine sand was more desirable and there was a vibration from one to the other with corresponding changes in the consistency of the asphalt cement.

To-day we are better informed as to what kind of sands will produce a satisfactory surface mixture and know

GUTTER IN WHICH WATER FLOWS.




GUTTER CARRYING NO WATER.

ACTION OF WATER ON GUTTER OF STREET PAVED WITH BERMUDEZ ASPHALT AT READING, PA.

the one that has generally been employed hitherto, without regard to the fact that no surface mixture, no matter of what asphalt it is made, can support traffic without disintegration unless it is itself supported by a base so rigid as to prevent vibration. The construction of a pavement with such a base, 6 or more inches of Portland cement concrete, will, of course, increase the cost of the pavement, but, as Mr. Whinery says, this is not a valid objection if the pavement yields better service per dollar invested. There can be no question that the asphalt pavements on the streets of New York would give better service if they were properly supported.

Between the base and the surface coat of an asphalt pavement it is usual to place a so-called binder course composed of broken stone of rather uniform size, free from fine material, and coated with an asphaltic cement. The purpose of this course is to prevent displacement of the asphalt surface on the smooth hydraulic concrete base. It has proved a most excellent form of construction on streets where the traffic is not excessive, but where travel is large in volume and particularly where the individual vehicles are very heavy it has been found that this open binder crushes under traffic, and no longer affords suitable support to the asphalt surface. The surface is also, under such conditions, forced into the voids in the binder and is thus itself displaced. Recent experience has shown that on streets of heavy travel this form of binder should be replaced by one in which the voids in the broken stone are filled with finer material, either grit or sand, or both, thus making a binder course which will resist displacement as satisfactorily as the hydraulic base or the asphalt surface. That such construction is satisfactory has already been shown to be the case, and it should be provided for on all heavy traffic streets in the future. This will mean an additional expense, as such a mineral aggregate will require a much larger percentage of bitumen to cement it together than the ordinary open binder, but that the so-called grading of the particles according to a well-defined plan is the most important consideration to be borne in mind, together with the combination of this graded sand with a proper amount of filler or mineral dust to form the mineral aggregate of the surface mixture.

A proper amount of filler or dust has rarely, until within the last few years, been used in asphalt surface mixtures, and even to-day it is too often absent from many of them. In the early days of the industry more than 4% was seldom used and often less than this. The character of the dust at that time was very coarse, so that probably no more than 50% of that in use was sufficiently fine to act as a filler. The result was that the asphalt street surface was porous and open and very liable to be attacked by the elements. To produce a mixture of the highest standard of excellence it is found necessary to prepare a specially ground dust of which at least 80% shall pass a 200 mesh sieve, and at least 65% shall be fine enough to remain suspended in distilled water when agitated with it for some time and allowed to settle for 15 seconds. Of such a dust from 8 to 10% should be a part of any mixture which is to withstand heavy traffic and a very great improvement in the mixture will be determined if a finely ground Portland cement is used for this purpose. The proper use of the filler in an asphalt pavment is something that is seldom considered although it is an element of the greatest importance, especially in protecting the surface from the action of water.

A very large amount of the rapid deterioration of asphalt surface under heavy traffic has been shown by experience to be due to defects in the grading of their mineral aggregate.

It now remains to be considered what bearing the character of the asphalt cement has in affecting the wearing properties of the asphalt surface, if it is granted that the base and binder are of the character that have been described and the sand grading and amount of [illegible] satisfactorily arranged.

To begin with there is no question that if [illegible] these conditions are not fulfilled, the asphalt surface will deteriorate eventually, no matter what the character of the bitumen which cements it together; and it [illegible] possible to accept the conclusion of Mr. Whinery when he says; "Obviously the quality and utility of the [illegible] (wearing surface) will depend mainly upon the [illegible] and the enduring quality of the cementing material."

The experience of many years has shown [illegible] the grading of the mineral aggregate, uniformity [illegible] the asphalt itself and the care exercised in combining [illegible] two materials, especially as far as regulation of the temperatures at which the mixture is made and [illegible] in the mixing is concerned, have much more [illegible] with the quality and uniformity of the compound than the nature of the asphalt in use. This may be illustrated by the fact that the same asphalt placed in the hands of different contractors, one highly skilled and working under laboratory control and the other a mere rule of thumb man, will give results which in one case might be to the credit of the material and the other to its discredit. Under these circumstances it is well to consider which asphalt is the most uniform and contains the bitumen which will suffer least from careless treatment and from the inevitable irregularities, either great or small, which are met with in any plant where asphalt surface mixtures are turned out.

It will be universally acknowledged that no source of supply yields such a uniform material as the Trinidad Pitch Lake. Examination of the various cargoes of this material taken from the lake during the last 15 years shows that they are all so extraordinary similar in composition that no practical difference can be detected between them. Trinidad lake pitch contains about 56% of a bitumen which is astonishingly free from hydrocarbons that are volatile at the temperature at which it is necessary to maintain an asphalt surface mixture. When this bitumen is fluxed with a heavy petroleum oil, specially made for this purpose, which is also free from hydrocarbons volatile at this temperature, an asphalt cement is obtained which is not only extremely stable, in consistency when maintained for a considerable length of time at a high temperature, but also hardens to a minimum amount when tossed about loosely in the mixer in contact with hot sand.

Trinidad lake asphalt contains about 35% of an impalpable fine powder consisting largely of quartz and clay which is uniformly mixed with the bitumen by nature. No artificial filler added to the mineral aggregate can, in the short time which it is possible to afford for mixing it with the mineral aggregate, become so thoroughly incorporated with the bitumen as is this natural filler in Trinidad asphalt. Trinidad asphalt contains a certain amount of organic matter not bitumen. This is not of vegetable origin but is derived from certain changes in the bitumen itself owing to the conditions under which the asphalt is formed. If properly sealed up in the surface mixture, it also acts as a filler. Trinidad lake asphalt, therefore, possesses numerous desirable qualities which are not attributes of any other native asphalt. It is granted, of course, that when it is immersed in the laboratory in water for any considerable period of time it is more or less disintegrated thereby, but it is far from true, as asserted by Mr. Whinery, that the bitumen is

"apparently disintegrated and changed to an inert earthy appearing [illegible]." No matter how long Trinidad asphalt remains in water and how far it may become disintegrated, on drying and melting the bitumen is recovered without loss and quite unaffected. The action of the water is, probably, no mere absorption by the organic matter of a non-bituminous nature which it contains. If the surface of a cylinder of Trinidad asphalt which is immersed in water is compressed every day with a burnishing tool water ceases to act upon it and it does not disintegrate. If a surface mixture containing this bitumen is so built up that water cannot penetrate it readily it is so burnished by traffic that water does not act upon it. If a surface mixture of Trinidad asphalt cement contains Portland cement as a filler, it is not attacked even when immersed in water for long periods of time. The slight apparent disadvantage revealed by laboratory tests of Trinidad asphalt are more than overcome by the great advantages which it offers in the character of the bitumen which it contains, the fact that it can be heated to a high temperature without being damaged, and by the presence of a natural filler which it carries so intimately mixed with the bitumen by nature.

As a matter of fact, since the introduction of the modern high grade Trinidad asphalt surface mixture, built up on the lines which have been previously laid down in this article, the old difficulty of disintegration due to the action of water on this asphalt has been entirely done away with.

It will, of course, be answered at once that Trinidad asphalt surfaces are still attacked by water under certain conditions. No denial can be made to this assertion, but to one who has had a wide experience with pavements constructed with other bitumens it is evident that under certain conditions all asphalt surface mixtures are attacked by water and there is no preference in favor of one or another. Where water is allowed to flow constantly over the gutters of an asphalt pavement they will disintegrate. Where water is allowed to permeate through the base or between the base and the surface of an asphalt surface they will be disintegrated, but neither of these conditions should be allowed to exist. Trinidad asphalt pavements have disintegrated in Washington, D. C., where water, impregnated with illuminating gas, has been allowed to reach the lower side of the asphalt surface. In Reading, Pa., where the house drainage is conducted along the asphalt gutters these gutters have entirely disintegrated, although they were composed of Bermudez asphalt. In this respect there is preference between the one or the other asphalt except that the deterioration in Reading is much more serious than would have been the case if a high grade Trinidad asphalt surface mixture had been used in constructing them.

The American form of asphalt pavement was introduced in London, England, in 1894, and the surface was constructed of Trinidad asphalt. The modern methods of making a mixture to withstand a wet climate and heavy traffic were not known at that time. The results were that the pavements were not an entire success and scaled. It was suggested that this was due to the fact that the asphalt in use was Trinidad and that this was constantly attacked by the continuous fogs of London. The pavements were, therefore, replaced in the following year with a mixture made with Bermudez asphalt. These surfaces went to pieces much more rapidly than the previous Trinidad surfaces. By this time the principles which have been elucidated in the earlier part of this article had been largely worked out. In the third year Trinidad asphalt surfaces were laid in London which not only were not attacked by the continued wet weather and fogs of that climate, but which have remained there to the present time, having shown in no part, even in the gutters, any deterioration due to water action. If the Bermudez surfaces had been constructed with the same regard to the mineral aggregate and to the character of the asphalt cement prepared from it they would undoubtedly have shown an equal freedom from the action of water but it is not probable that they would have shown an equal resistance to the deteriorating influence of the heavy traffic on the streets on which the pavements were laid. Practical experience rather than theory, therefore, has led the contractor of wide experience to prefer the Trinidad material to other asphalts because it can be put in the hands of the yard foreman and suffer without injury greater carelessness and irregularity in handling than any others. Trinidad asphalt is the only one of which a mixture can be turned out in winter at such a temperature that repairs can be made with it without danger of being seriously injured by the high temperature necessary for work at that season.

It remains to consider what the disadvantages are, in comparison with Trinidad asphalt, of those asphalts which are not acted upon by water in the laboratory, it having already been shown that they are as readily or more easily destroyed in the street by the continuous action of water, as illustrated in London and Reading. The difficulties with these asphalts may be illustrated by a consideration of the character of Bermudez asphalt, by far the best one of this type. Bermudez asphalt and all the other native bitumens, with the exception of Trinidad, offer a supply far from uniform in character. No two cargoes of asphalt from the Bermudez deposit are of the same consistency. As an example the following figures will serve. They represent the length of flow upon a corrugated brass sheet of four cylinders of this asphalt of equal size and weight when exposed to a temperature sufficiently high to induce a movement.

| | | |
|---|---|---|
| Washington, | 1893 ..... | 100% |
| Cargo No. | 1 ..... | 50% |
| " | " 2 ..... | 42% |
| " | " 3 ..... | 78% |
| " | " 4 ..... | 73% |

For comparison with these four cargoes the relative flow of the original Bermudez brought to Washington in 1893 is given. The great irregularity in the consistency of the material is made evident. Such an irregularity necessitates much greater skill on the part of the yard foreman in preparing his asphalt cement and is more apt to lead to lack of uniformity in the work. This lack of uniformity led to the laying of a very large yardage of inferior Bermudez pavements in the West some years ago, as no departure was made from the formula laid down by De Smedt in 1893 that this asphalt should be fluxed with 14.5 lbs. of oil per 100 lbs. of asphalt, while the asphalt in the meantime was most variable in its consistency.

Bermudez asphalt cement cannot be maintained at high temperatures with the same freedom from injury that is the case with Trinidad asphalt cement. If it is mixed with a hot sand, and the sand at times unavoidably becomes hotter than is necessary and desirable at any paving plant, it is very much hardened in consistency and loses much of its cementing value and on this account requires the very greatest care in its use.

Owing to the fact that Bermudez asphalt contains no natural filler, it is necessary that an additional amount, over and above that required by the Trinidad mixture, shall be added to the mineral aggregate when this bitumen is used as a cementing material. It is somewhat difficult to use this large amount and always difficult to thoroughly incorporate it in the mixture. For these two reasons Bermudez asphalt and the same may be said of other Venezuelan supplies, is not as desirable as Trinidad material. These asphalts are, however, attractive to the contractor since they increase the capacity of his plant, as 100 lbs. of Bermudez asphalt goes as far as 150 lbs. of Trinidad asphalt. It is probable that with Bermudez asphalt the amount of bitumen in the mixture is somewhat reduced as compared with that of Trinidad asphalt. Notwithstanding this the experimental contractor, to whom Trinidad asphalt is available, prefers from his experience at the plant and on the street and from his knowledge of what the maintenance of the two forms of pavement has been to use the Trinidad asphalt. To those who theorize and observe pavements for a different point of view the purer asphalts may seem preferable to Trinidad, but to the practical man, who bases his conclusions on dollars and cents, there can be no question that among the asphalts available to-day for paving purposes Trinidad asphalt holds the palm if it is properly handled, and the construction of the surface is such as to permit it to make its best showing. Other asphalts or bitumens of a similar nature may become available in the future which will possess qualities which are so far preferable to Trinidad asphalt as to overcome the advantages derived from being able to heat this to high temperatures and from the natural filler which it contains, but such materials are not yet upon the market.

Very truly yours, Clifford Richardson.

Long Island City, N. Y., May 17, 1904.

(A proof of the above contribution was submitted to the author of the series of papers on Pavements, Mr. S. Whinery, and we append his reply as follows:—Ed.)

Sir: I have read with great interest the communication of Mr. Clifford Richardson, commenting upon some of the views expressed in my Article No. X., on pavements, particularly with reference to the value of different kinds of bitumens for constructing asphalt pavements.

With much that Mr. Richardson says, every one who has had practical experience in the construction of asphalt pavements will heartily agree. Those who feel compelled to disagree with certain of his statements and conclusions do so, I am sure, with the greatest respect for his opinions, and with a high appreciation of the very valuable services he has rendered in this particular field of engineering work. The great improvements that have been made in the construction of asphalt pavements in the last decade are largely due to the careful and effective investigation in which Mr. Richardson has taken a leading part.

It is worth noting, incidentally, that Mr. Richardson does not approve of the use of the so-called binder-course with all asphalt pavements. The writer has always believed that this binder-course is somewhat worse than useless under any asphalt pavement. Its use may be excused as a comparatively cheap material for leveling up uneven foundations, such as are sometimes met with where an old stone pavement is utilized as a foundation, but even here hydraulic concrete would be better and cheaper. The claim that a binder-course prevents the waving or "rolling" of the asphalt surface is unsupported by satisfactory evidence. Many years ago, when binder-courses first became fashionable, a number of streets in two large cities where the necessary permission could be obtained, were paved with asphalt, using binder and the old-fashioned "cushion-coat" in alternate sections on the same blocks. In some of the cases one-half the width of the street was paved in the one way and the other half in the other on alternate blocks and the results were carefully observed for several (in some of the cases five) years. The streets varied greatly as to quantity and character of travel. In most of the cases no difference was observed in durability or in perfection of surface between the adjoining sections of pavement; but where a difference was observable it was invariably to the disadvantage of the binder-course sections. There can be no doubt that recent pavements show less tendency to "roll" than the earlier ones, but the result is due to causes other than the use of binder.

In commenting upon a sentence quoted from my article, Mr. Richardson construes the language too literally. I assumed that the reader would understand that what I meant to say was, "Other things being the same, 'obviously the quality and utility of the compound will depend mainly upon the strength and the enduring quality of the cementing material'." It would be absurd to claim that even an ideally perfect asphaltic cement would neutralize defects in the other ingredients, or want of skill in compounding and laying the pavement. All that Mr. Richardson says about the necessity for careful selection of all the materials used and the employment of a high degree of knowledge and skill in the whole operation is true and cannot be too strongly emphasized. There can be no doubt of the necessity of a sufficient foundation to support the pavement, of the importance of properly selecting and grading the sand, of using a proper quantity and quality of mineral dust, of making the pavement as nearly impermeable to water as possible, and of careful and scientific treatment of the work at every stage. The very great advances that have been made in the construction of asphalt pavements in recent years are largely due to improvements along these lines, and Mr. Richardson is entitled to full credit for the large share he has had in bringing them about. But admitting all that he says on these points, it still remains obviously true that the prime element in an asphalt pavement is the cement—the bitumen, and that with equally good other materials and equal skill the quality of the pavement must vary with the quality of the asphaltic cement used. If one asphalt is found to possess the requisite qualities and is also free from the defects of others, that asphalt should, per se, be preferred. The principles that have been developed in the selection of the other materials and in the constructive details of the pavement are, in the main, equally applicable, whatever variety of asphalt may be used.

The argument based upon the greater practical difficulties in the proper manipulation of asphalts other than Trinidad, while not without some weight, particularly to the contractor, should not be taken too seriously. The fact that one material requires more careful manipulation than another is not a valid reason for its rejection, unless it may be shown that the difficulties encountered are of such a character that they cannot be readily overcome, which, in the case we are considering will hardly be claimed. Similar objections have been raised against most of the notable advancements in engineering and industrial processes. No engineer prefers lime mortar because the latter may be spoiled by careless workmen. Different asphalts undoubtedly require somewhat different manipulation, and it may require some study and experiment to determine the best treatment for each; but that fact is not, in itself, a sufficient reason for clinging to an inferior kind.

Nor can Mr. Richardson's argument, based upon the greater uniformity in quality of the Trinidad asphalt as it appears in the market, be accepted without inquiry into the cause of this greater uniformity. If it should appear, for instance, that lack of uniformity may be accounted for by differences in the care with which the various asphalts are mined and refined, the argument loses its force. The great asphalt deposit on the Island of Trinidad is not all of uniform quality and consistency. Beginning with soft, almost liquid, bitumen, recently exuded from the subterranean source of supply near the center of the lake, older and more oxidized material is met with as we approach the shore, and beyond this is found the detached deposits of "land asphalt" which, while they doubtless had the same origin, are now admittedly inferior in quality. But care in selecting and refining the crude material from the lake has given us a refined asphalt that is quite uniform in quality and consistency, though the experience of the writer does not confirm the unqualified claim of uniformity made by Mr. Richardson. Is Mr. Richardson prepared to say that with proper care in selecting and refining the Bermudez asphalt, the product would not be equally as uniform in quality? Or that, even as it now appears in the market, it is not practicable by modern methods of treatment at the paving plant to make from it a first-class pavement?

Mr. Richardson's statement that all asphalt pavements are affected by water, while literally true, must be accepted with very important reservations. Most construction materials are, as is well understood, more or less affected by moisture. Wood, when saturated with water, has less strength and resistance than when perfectly dry. Even the best granite block pavement would undoubtedly

be more enduring if it could be kept entirely free from water. In the same sense any asphalt pavement is affected by moisture; when its pores are filled with water it has less strength and resistance than when perfectly dry. But impairment in this sense is quite a different thing from actual disintegration and destruction of the substance itself when exposed to water. That Trinidad asphalt undergoes such disintegration in the presence of water cannot be denied; that some other asphalts do not disintegrate under the same conditions of exposure Mr. Richardson will, I am sure, admit. The experiments referred to by Mr. Richardson merely prove that if the water can be kept out of Trinidad asphalt, disintegration will be prevented or delayed, and are hardly germane, unless a method can be devised to entirely prevent the absorption of moisture by a pavement, either from the surface or the base. As stated in my article, much has been accomplished in this way in recent practice, and to that extent the pavements have been improved. But practical difficulties must obviously always prevent the attainment of complete imperviousness to moisture.

But when Mr. Richardson says that, ". . . to one who has had a wide experience with pavements constructed with other bitumens [than Trinidad] it is evident that under certain conditions all asphalt mixtures are attacked by water and there is no preference in favor of one or another." the question arises: to what "certain conditions" does he refer? He will not, I am sure, undertake to say that under any ordinary conditions of use asphalt pavements are equally affected by water regardless of the kind of asphalt used in their construction.

It being conceded that the refined Trinidad asphalt itself disintegrates when exposed to water, and that some other asphalts do not, it might safely be presumed, in the absence of experimental proof, that they would retain their characteristics when mixed with neutral mineral matters, as sand and pulverized stone. But we are not without the experimental proof. Let any one who may entertain any doubt upon this point subject samples of pavement made of Trinidad asphalt, and, say, of Bermudez asphalt, to the same conditions of moisture or water for 90 days and then examine their relative physical condition. If, at the same time, he desires to verify the truth of the writer's statement that Trinidad asphalt exposed to water becomes "apparently disintegrated and changed to an inert, earthy appearing mass" let him pulverize a sample of Trinidad asphalt, place it in a jar, fill the jar with water, allow it to stand for three months, and then observe the result. It is true that by drying the residue and exposing it to heat he will obtain bitumen apparently as good as the original. But the possibility of thus reviving the virtue of the bitumen has no useful bearing in dealing with a disintegrated pavement.

It is true that in so far as the pavement or the sample of asphalt may be prevented from absorbing water by filling its pores or by burnishing its surface, disintegration may be prevented or delayed, and, as Mr. Richardson says, much of the recent improvement in the quality of Trinidad asphalt pavement is due to efforts in this direction. That these efforts have been, or can be, completely successful, however, will hardly be claimed.

The writer appreciates the good qualities of Trinidad asphalt. Barring its susceptibility to deterioration in the presence of water, it probably has no superior—perhaps no equal—for making pavements. But after much observation, study and experiment he has been forced to the conclusion that this defect is so serious as to be controlling, and that while it may be mitigated it is practically incurable; and that, therefore, upon the whole, better results in paving are to be expected from the use of other asphalts.

It is not, of course, possible to estimate accurately the damage and loss to cities and to contractors occasioned by the destruction of asphalt pavements by water, but observation and experience has convinced the writer that this loss is greater than from all other causes of pavement deterioration combined, not excepting very heavy travel. Water is the greatest enemy of Trinidad asphalt pavements.

S. Whinery.

95 Liberty St., New York, May 31, 1904.

## Notes and Queries.

J. B., Uhrichsville, O., writes:

You would greatly favor me by answering through Engineering News the following question:

Does Eastern time correspond to the meridian of Washington?

Eastern time is exactly five hours later than Greenwich time, or in other words, eastern time is the correct astronomical time of the meridian 75° west of Greenwich. This meridian passes near Philadelphia. Central time, six hours later than Greenwich time, is astronomically correct for the meridian 90° west of Greenwich, which passes a little east of St. Louis.

E. G. S. writes that the letter in our issue of May 19, describing a method of plotting a curve of large radius, gives a process practically identical with that described in Kent's "Pocket Book," 5th ed., p. 39, Art. 14, and p. 51, Art. 54.

## ELECTRIC LOCOMOTIVES FOR THE NEW YORK CENTRAL & HUDSON RIVER R. R.

The new electric locomotives which are being built for the New York Central & Hudson River R. R. Co. at Schenectady, N. Y., by the General Electric Co. and the American Locomotive Co., differ radically in their electrical features from any electric locomotive hitherto constructed. For this reason engineers will be interested in the following illustrations and description of these machines, which have been prepared and furnished to us by the General Electric Co.

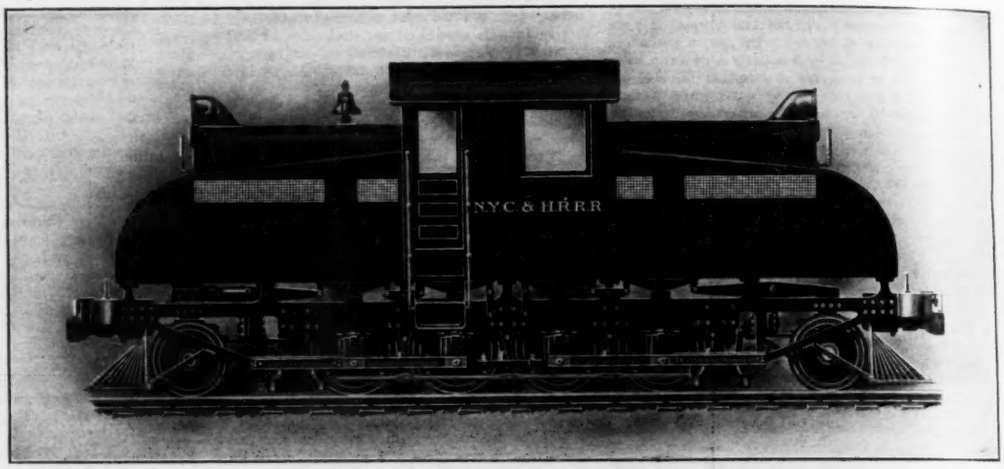



FIG. 1. ELECTRIC LOCOMOTIVE FOR THE NEW YORK CENTRAL & HUDSON RIVER R. R. General Electric Co., and American Locomotive Works, Schenectady, N. Y., Builders.

The motors are bi-polar and gearless, the magnetic circuit and the field windings and the motor poles being integral with the locomotive frame and spring supported. The pole faces which are laminated are vertically tangential to the armature, thus providing for vertical movement of the locomotive frame with attached poles without affecting the armature air gap. The armature is assembled on a quill which is pressed solidly on the axle. The dual weight of the assembled rotating part, including the armature, axle and wheels, is less than on many steam locomotives, and, there being no uncompensated reciprocating parts, there is a perfect rotative balance.

This design was submitted in accordance with specifications prepared by the Electric Traction Commission appointed by the railway company, the members of which are Messrs. Wm. J. Wilgus, Fifth Vice-President; John F. Deems, General Superintendent of Motive Power; Bion J. Arnold, Frank J. Sprague, and George Gibbs. The Secretary to this Commission is Mr. Edwin B. Katte, Electrical Engineer of the railway company.

This Commission, after careful deliberation, had prescribed the conditions which must be fulfilled by electric locomotives taking the place of steam locomotives as far as Croton on the Hudson River line and as far as North White Plains on the Harlem Division, a distance of 34 miles and 24 miles, respectively.

These conditions were, briefly, that the successful bidder should furnish an electric locomotive capable of making two regular successive trips of one hour each between Grand Central Station and Croton with a total train weight of 550 tons, a single stop in each direction and a lay-over not to exceed 20 minutes. In addition to this it was provided that a similar schedule should be maintained with somewhat lighter trains making more frequent stops. Finally, it was provided that with a total train weight of 435 tons, the [illegible] locomotive should be able to run from G[illegible] Central Station to Croton without stop in 44 [illegible], and, with one hour lay-over, be able to [illegible] up this service continuously. This last sch[illegible] is the equivalent of the present timing of the Empire State Express, though the latter has [illegible] somewhat lighter train.

Specifications embodying these conditions were prepared by the Commission and sent to all the principal electrical manufacturing companies both here and abroad. It will be observed that no restriction was placed on bidders as to whether direct or alternating current was to be used. The successful bidders were the General Electric Co. in conjunction with the American Locomotive Co. The choice of a direct current type of locomotive was dictated largely by its known reliability of service, owing to the amount of experience which had been accumulated with the direct current motor.

The new electric locomotive will be 37 ft. in length over all. The wheel base will consist of four pairs of motor wheels and two pairs of pony truck wheels, the length of the total wheel base being 27 ft.; and of the rigid wheel base, consisting of the four pairs of motor wheels, 13 ft. The diameter of the driving wheels will be 44 ins., and of the truck wheels 36 ins. The driving axles will be 8½ ins. in diameter. The locomotive will be what is known as a double ender and will weigh approximately 190,000 lbs.

The frame will be of cast steel, the side and end frames being bolted together at machined surfaces and stiffened by cast steel cross transoms. The journal boxes and axles will be designed to permit sufficient lateral play to enable the locomotive to pass easily around curves of 250 ft. radius.

The superstructure of the locomotive is to be of steeple form so designed as to offer the least practicable wind resistance consistent with the adequate housing of the apparatus and its convenient operation. The cab is designed so as to afford a clear view of the track. The whole of the superstructure is to be of sheet steel with angle iron framing, and the doors and windows of the cab are to be fireproof.

The driving power of the locomotive will be furnished by four 600 volt direct current gearless motors, each of 550 HP. This will make the normal rating of the locomotive 2,200 HP. with a maximum rating of about 2,800 HP., or about 50% greater than that of the largest steam passenger locomotives now in service.

The armatures will be mounted directly on the axles and will be centered between the poles by the journal boxes, sliding within finished ways in the side frames. The armature core will be of the iron-clad type, the laminations being assembled on a quill which will be pressed on the axle. The winding will be of the series drum-barrel type. The conductors will be designed so

as to avoid eddy currents and will be soldered directly into the commutator segments.

The commutator will be supported on the quill. The commutator segments will be made of the best hard drawn copper and will have the ears integral with themselves. The brush-holders will be made of cast bronze and mounted on insulated supports attached to the spring saddle over the journal, maintaining a fixed position of the brush holder in relation to the commutator.

Unlike the ordinary four-pole motor where the magnetic circuit is made through a separate box casting, the magnetic circuits in this type of electric locomotive are completed through the side and

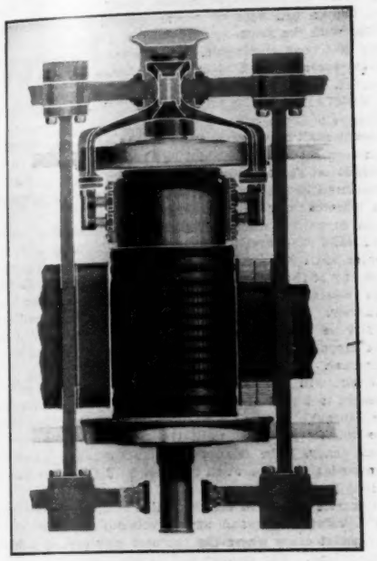


Fig. 2. Plan of Armature, N. Y. C. & H. R. R. R. Electric Locomotive.

end frames. The pole pieces are cast in the end frames and there are also double pole pieces between the armatures carried by bars which act as part of the magnetic circuit.

The pole pieces will be shaped so that the armature is free to move between them with ample clearance on the sides. As the poles move up and down with the riding of the frame on the springs, they will always clear the armature and provision is made so that the armature will not strike the pole pieces even if the springs are broken. The field coils will be wound on metal spools bolted to the pole pieces and will consist of flat copper ribbon.

The Sprague-General Electric multiple unit control will be used on this type of electric locomotive. There will be two master controllers in the cab so placed that the operating engineer looking ahead will always have one of these under his hand. The control system will permit two or three locomotives to be coupled together in any order in which they happen to come and to be operated as one unit by the engineer in the leading cab.

The control system will also be semi-automatic in its action as it will provide a check on the rate of acceleration of the train, which the engineer cannot exceed, while he may accelerate at any slower rate if he so desires. Should two locomotives break apart the control current will be automatically and instantly cut off from the second locomotive without affecting the ability of the engineer in charge to control the front locomotive under his charge. The control system is designed for a minimum of 300 volts and a maximum of 750 volts.

The weight which will rest upon each of the driving wheels of the electric locomotive will be about 17,000 lbs. Proper distribution and division of the weight among axles will be accomplished by swinging the main frames from a system of elliptical springs and equalizing levers of forged steel, the whole being so arranged as to cross equalize the load and furnish three points of support.

The locomotive will be provided with all the usual accessories of a steam locomotive including an electric air compressor to furnish air for the brakes, it will have whistles, a bell and an electro-pneumatic sanding device and electric headlights at each end. The interior of the cab will also be heated by electric coils.

In actual performance this locomotive is expected to give better results than any engine hitherto placed upon rails. With a light train the locomotive is expected to give speeds up to 75 miles an hour and with heavier trains similar speeds can be attained by coupling two locomotives together and working them as a single unit. Its tractive force will be greater than that of any passenger locomotive now in existence, and it is believed that in the simplicity and accessibility of its parts and in the provision made in its design to insure continuous operation with the minimum chances of failure, that it marks an entirely new and successful type of electric locomotive.

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**COMPARTMENT DAY CARS** are a novel feature in American railway practice, but are now being introduced by the Chicago & Eastern Illinois Ry. They differ from the European "corridor" cars in having the usual central aisle instead of a side corridor. The new cars are chair cars, with four chairs in each compartment on one side of the aisle, and two chairs in those on the other side. A table can be fitted in the space between the chairs. The compartments are 6 ft. 8 ins. long, 4 ft. 2 ins. and 2 ft. 6 ins. wide for the two and four seat arrangements, and the aisle is 2 ft. 4 ins. wide. There are no doors in the openings to the compartments. The cars are 72 ft. long over the end sills, exclusive of the vestibuled platforms. They were built by the American Car & Foundry Co., of St. Louis, Mo.

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## EXCAVATION AND RETAINING WALL FOR THE PENNSYLVANIA R. R. TERMINAL STATION, NEW YORK CITY.

The engineers' plans have been completed, and bids are now being asked for the construction of the underground portion of the new Pennsylvania R. R. terminal station in New York City. As some of our readers will remember, the new terminal will occupy the four city blocks bounded by 33d and 31st Streets on the north and south and by Seventh and Ninth Avenues on the east and west. Fig. 1 is a sketch plan of the site, and the broken line defines the inner toe of the enclosing walls.

To understand the purpose of the work referred, it is necessary only to call to mind that the Pennsylvania R. R., now terminating on the New Jersey shore of the North River, and also owning the railway system on Long Island, proposes to connect its two systems, and at the same time secure a terminal in New York City by building a tunnel from the New Jersey shore under the North River, Manhattan Island, and the East River to Long Island. The underground terminal is on the line of this tunnel, and is, in fact, practically a lateral enlargement of the tunnel line between Seventh and Ninth Avenues, which will be covered by the station and other terminal structures. The tunnel lines proper were described in Engineering News of Oct. 8, 15 and 29, and contracts for their construction have been awarded, as noted in Engineering News of March 17, 1904. The present article will describe briefly the contract plans for the underground terminal and its construction.

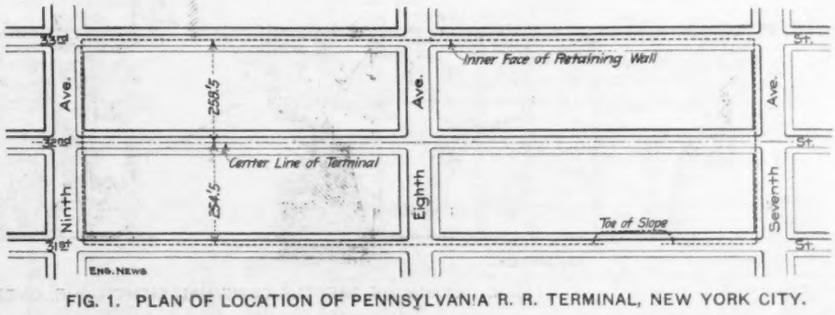



FIG. 1. PLAN OF LOCATION OF PENNSYLVANIA R. R. TERMINAL, NEW YORK CITY.

In exact figures the space inclosed by the terminal will be about 1,700 ft. long east and west and 500 ft. wide. As will be noticed from Fig. 1, the width of the enclosure brings the north and south walls well under 33d and 31st Streets. These streets, therefore, will be occupied underneath for parts of their widths by the terminal structure, and must be supported by bridging both during and after construction. The depth of excavation to subgrade over the whole area specified will be from 40 ft. to 60 ft. below the present street surface, and this excavation will be bounded on all four sides by retaining walls. Roughly speaking, the construction work called for by the present plans consists of excavating some 1,652,000 cu. yds. of earth and rock and of building about 4,300 ft. of retaining wall to enclose this excavation.

EXCAVATION.—The subsoil of the terminal site consists of earth overlying rock, and all material except ledge rock requiring blasting is classified as earth. There will be approximately 788,200 cu. yds. of rock and 864,200 cu. yds. of earth to be excavated. The only portion of this excavation that calls for special mention is that which encroaches on the streets bounding the terminal site. This will consist first of the trenches for the retaining walls, and second, that part of each street which falls inside the inner wall line. The amount of this work may be judged from the sketch plan, Fig. 1.

It is specified that the trench for retaining wall shall be sheeted, and shall have a top width exceeding by not more than 6 ft. the width of the base of the wall, except where street conduits have to be rebuilt behind the wall. No more than 800 ft. of trench may be opened in any street at one time, and the remaining portions of the street must be kept in a satisfactory condition for traffic. The trench excavation is to go down to solid rock everywhere, except where this is more than 10 ft. below the top of rail level, and the top of the rock is to be dressed smooth, or where sloping, cut into steps. Upon completion of the wall in the trench, the open excavation behind its rear face is to be back-filled and the street surface restored to its original condition, or planked over where this restoration is impossible.

As soon as excavation is begun inside the walls, all that portion of the street is to be replaced by a timber platform. The width and construction of this platform will vary, but its general character is shown by the drawings of Fig. 2. The length of platform in 31st St. will be about 1,600 ft., and that in 33d St. will be approximately the same length. In addition to the platforms on 31st and 33d Sts. the portion of Eighth Ave. between these streets is to be maintained on trestles during and after excavation. This trestle will be about 455 ft. long, and its construction is shown by the drawings of Fig. 3.

In excavating inside the walls, it is specified, in order to avoid injury to the rock on which the retaining walls stand, that the sides of the rock excavation shall be formed by drilling and broaching. The other requirements for excavation are such as are usually demanded in rock and earth excavation for building foundations.

RETAINING WALLS.—The retaining walls enclosing the excavation will vary in depth, owing

to the irregular elevation of rock surface, about from 12 ft. to 50 ft. Fig. 4 is a cross-section of the wall at one of the highest points and a plane passed through this section at any level will give above it the cross-section for that height of wall. The construction of the walls is best described by the specifications, which are as follows:

The wall shall be built in sections not more than 50 ft. long. Each section shall be commenced by laying a 4-in. brick wall at the back, to the height of the first full width offset, to lay the waterproofing upon. The waterproofing will consist of four layers of coal tar pitch, and three of felt. The pitch shall be straight run coal tar pitch which will soften at 60° F. and melt at 100° F., being a grade in which the distillate oils distilled therefrom have a specific gravity of 1.105. The felt shall be "Hydrex" felt manufactured by F. W. Bird & Son, of East Walpole, Mass., or felt equally satisfactory to the engineer. The inequalities in the surface of the brick masonry shall be leveled up with mortar, and after it has set, pitch shall be mopped on the surface to a uniform thickness of not less than 1-16-in. Immediately on this coat of pitch, and while it is still melted, there shall be laid a covering of felt, the sheets to lap not less than 4 ins. on cross joints, nor less than 12 ins. on longitudinal joints, and to be made to adhere properly to the pitch-covered surface everywhere. This felt layer shall be mopped with pitch as above specified, another layer of felt added, and the process continued to the full number of layers required. The waterproofing shall extend over the top of the brick masonry, and 6 ins. down the back; at the end of each section the waterproofing shall be carried across the end of the brick work and the waterproofing of the succeeding section lapped on 4 ins. These laps will be included in the area paid for.

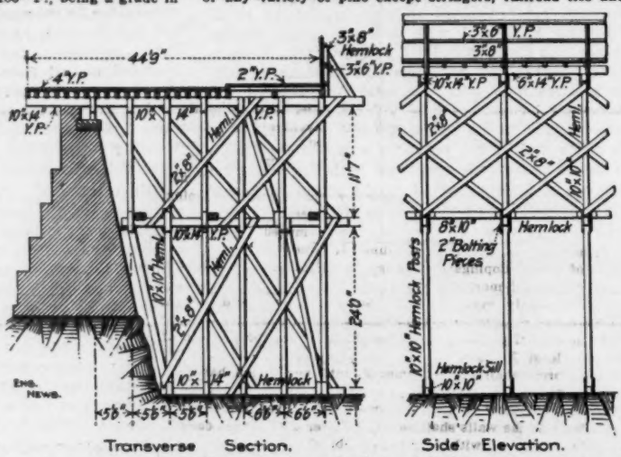



FIG. 2. DETAILS OF TRESTLE PLATFORM SUPPORTING STREETS OVER EXCAVATION.

The waterproofing and the protecting mortar and brick masonry must be protected from injury by working or walking thereon. Any damage done to the retaining wall, its waterproofing or protecting masonry shall be repaired by and at the sole cost of the contractor to the satisfaction of the engineer.

After placing the waterproofing above described, a layer of mortar 1 in. thick shall be laid on the rock surface and the concrete in the section shall be placed, working night and day continuously until the section is finished. The back of the wall above the brick masonry and also the horizontal offsets shall then be plastered with mortar ½-in. thick, and then waterproofed, with pitch and felt in the manner described in the preceding paragraph, bonding 6 ins. down the back of the brick masonry with the waterproofing previously placed thereon. The waterproofing will then be covered, both on vertical and horizontal surfaces, with a 4-in. layer of brick masonry laid in mortar and the exterior surface of the brick work plastered with a ½-in. coat of mortar, troweled smooth. The joint between adjacent sections shall be of the form shown by Fig. 5.

A vitrified drain pipe 6 ins. in diameter shall be laid behind the wall at its base; high points of rock shall be dressed off and low places filled with gravel to give as uniform a grade as practicable and a firm support. The drain shall be covered with 1 ft. of gravel or broken stone, and then covered with not less than 3 ins. of coarse sand, the grains of which shall be of such size that they will not fall into the voids of the gravel. At intervals of not more than 25 ft., vitrified pipe drains 6 ins. in diameter and connecting with the back drain with suitable tees shall be laid through the wall at its base and imbedded in concrete. The drain shall incline towards the face of the wall not less than ¼-in. per foot, and shall finish at the face with a bell-mouth flush with the face of the retaining wall.

DISPOSAL OF EXCAVATED MATERIALS.—The materials taken from the excavation are to be ultimately delivered and distributed on the property of the New York Bay R. R. Co., at Greenville, N. J., but the contractors' part of this work will consist only of putting the material on barges at the foot of West 32d St. in Manhattan. To facilitate the contractor's work, a pier will be provided at 32d St. for dumping purposes, and will be connected with the excavation by a trestle and incline. This structure will be located on private property, and will rise from 32d St. at a point just west of 10th Ave. On the pier the trestle will be arranged so that material may be dumped at either edge. A detail of the dumping arrangement is given by Fig. 6.

MATERIALS AND WORKMANSHIP.—The specifications for material and workmanship for the principal items of work, timberwork and concrete, are an abstract as follows:

TIMBERWORK.—Timber may be of spruce, hemlock or any variety of pine except stringers, railroad ties and floor planking, which shall be of long leaf pine. All timber shall be sawed accurately, free from rot, splits, shakes, large or loose knots, or other imperfections which, in the opinion of the engineer, may impair its strength and durability. No timber shall have wane on more than two corners and the maximum amount at any place shall not exceed 2 ins. Plank shall be entirely free from wane, and not less than 10 ins. in width, unless otherwise shown on the contract drawings.

Framing must be done in a thoroughly workmanlike manner, and no blocking or shimming will be allowed in making joints. Bolt holes must be bored true and those for drift bolts must be ⅛-in. less in diameter than the bolts.

Timber will be paid for by the 1,000 ft. board measure of actual contents erected and bolted to place, measured in the finished structure, and the price per 1,000 ft. will include the furnishing of all timber and plank, its transportation, labor of framing and erecting, and all expenses connected therewith.

BOLTS, SPIKES AND WASHERS.—Bolts for trestle work and flooring shall be of mild steel of good quality, free from flaws or other defects, with full threads, either rolled or cut, and heads and nuts square with the axis of the bolt. Spikes shall be of the best merchantable quality. Washers shall be of sound, tough cast-iron conforming in pattern to drawings furnished by the engineer.

SAND.—Sand for mortar or concrete shall be coarse, sharp and silicious, not containing more than 1.5% of mica, loam or clay, or of all combined, and equal in quality to the best Cow Bay sand. If required by the engineer, it shall be screened.

BROKEN STONE.—Sound rock excavated from the work may be used if hard, crystalline and practically free from mica. If a sufficient amount cannot be obtained from the work, sound trap or hard limestone must be furnished. Gneiss from other localities will not be accepted. The rock must be clean when delivered at the crusher. It shall be broken by machine and screened in a rotary screen which will remove all the dust and fragments that will pass through a hole ⅜-in. in diameter and all pieces which will not pass through a hole 1½ [illegible] diameter; all fragments between these limits will [illegible]tained. In special cases hereinafter specified the m[illegible]n size will be that which will pass through a hole ⅝ [illegible] in diameter.

BRICK AND BRICK MASONRY.—Brick [illegible] be of the best quality of building brick, sound, ha[illegible]ned entirely through, free from lime and other impur[illegible]egular and uniform in size and shape and of compa[illegible]ure. They shall be free from lamination and from [illegible] or checks of more than superficial extent. Bricks i[illegible]tly burned or broken will not be accepted. On deli[illegible] at the works, bricks shall be sorted by and at the ex[illegible] of the contractor for inspection by the engineer or [illegible] representative, and rejected bricks shall be rem[illegible] immediately from the work and its vicinity. Bricks [illegible] be immersed in water for at least 20 minutes before l[illegible]; they shall be laid in full beds of mortar and all [illegible] completely filled with the same. Joints must be bro[illegible] so as to give the best bond obtainable. The mortar in beds and joints shall average about ½-in. Close joints will not be permitted.

MORTAR, GROUT AND CONCRETE.—In proportioning materials for mortar, grout and concrete, 1 volume of cement shall be taken to mean 380 lbs. net. One volume of sand or broken stone shall be taken to mean 3½ cu. ft. packed or shaken down. Sand and broken stone shall be measured in barrels or rectangular boxes. Measurements in wheelbarrows will not be permitted.

In preparing mortar, the specified amounts of cement and sand shall first be mixed dry to a uniform color. The water shall be added in such a manner as not to wash out any of the cement and the mixing proceeded with until the mortar is thoroughly mixed and of uniform consistency. The proportions of cement and sand will generally be 1 to 2½ by volume, but when the work is wet, the proportion of sand shall be reduced as required by the engineer.

Grout will generally be in the proportion of 1 part of cement to 1 part of sand by volume. The materials shall be thoroughly mixed dry, and water then added, while the mixing proceeds, until the grout is of the required consistency. The mixing shall be continued vigorously, preventing the separation of sand, until the entire amount mixed is used.

Concrete will be in the proportion of 1 volume of cement to 3 volumes of sand and 6 volumes of stone, except in special cases where the engineer may require different proportions. For copings and bridge seats to a depth of 9 ins. and in narrow confined places, the smaller sized stone shall be used, and the proportions of sand and stone may be reduced to 2 volumes of the former and 3 volumes of the latter to 1 volume of cement. Whenever practicable the concrete shall be machine mixed; the mixing machine shall be a rotary mixer, and of a pattern that will mix the concrete in batches and permit the definite measurement of the materials for each batch. When the engineer considers it impracticable to mix by machine, it may be mixed by hand, in the same proportions as above specified. The mixing shall be done on a platform of boards or planks securely fastened together. The cement and sand shall first be mixed, and made into mortar, as described. The broken stone, previously wetted, shall then be added and the mortar and stone turned over with shovels until the mortar is uniformly distributed through the mass and every stone is coated with mortar.

Where the walls of concrete masonry exceed 6 ft. in thickness, masses of stone may be built in, such stone shall be clean, hard, compact and free from cracks or other unsoundness. They shall be set in at least 6-in. beds of concrete and have full bearings therein. They shall be set on their largest beds and shall be at least 6 ins. apart at every point and at least 12 ins. from the face of the wall. No stone shall be more than 2 ft. in thickness. The large stones shall not in the aggregate exceed 25% of the total volume of the masonry containing them.

The degree of moisture for mortar, grout and concrete shall be at all times as required by the engineer or his inspector; in general mortar shall be plastic, grout shall be fluid enough to be pumped, and concrete shall be of such consistency that it will quake when being deposited.

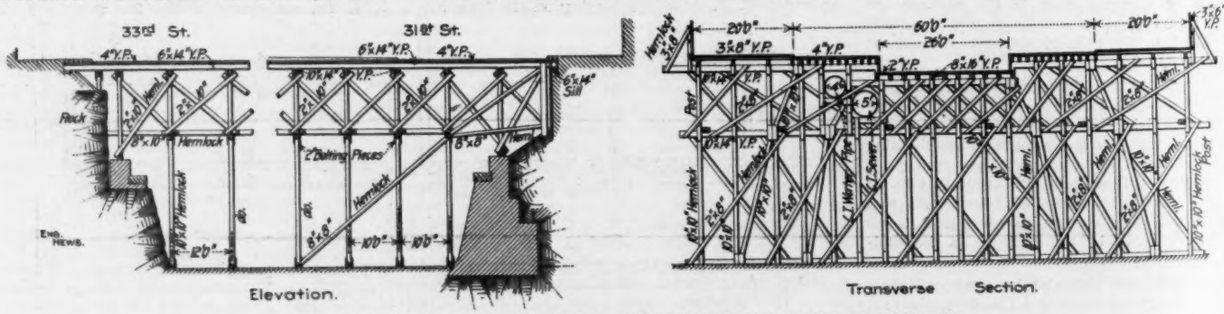



FIG. 3. DETAILS OF TRESTLE CARRYING EIGHTH AVE. OVER EXCAVATION.

but not wet enough to cause the stone to separate from the mixture.

Concrete shall be deposited in the work in such a manner as not to cause separation of mortar and stone. It shall be laid quickly in layers not exceeding 9 ins. in

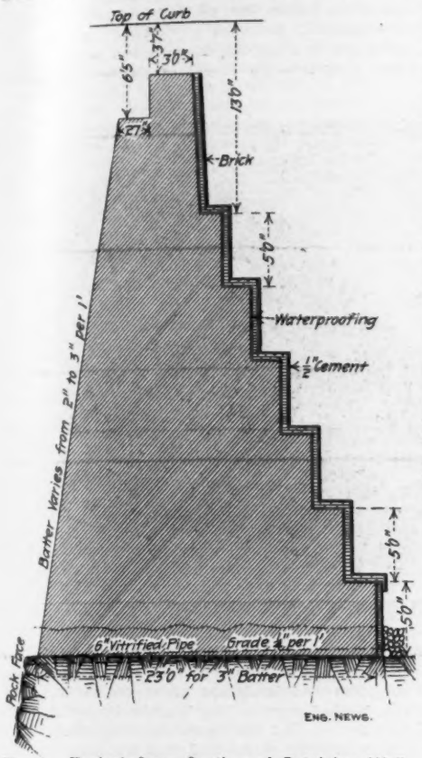



Fig. 4. Typical Cross-Section of Retaining Wall.

thickness, and thoroughly rammed with rammers of such form and material as the engineer may approve; special shaped rammers will be required for corners and other places where ordinary rammers would not be effective. Compact, dense concrete must be obtained with all the voids between the stones filled with mortar. If voids are discovered at any time, the defective concrete shall be removed and immediately replaced by concrete of such mix ture and in such manner as the engineer may direct.

When the placing of the concrete is suspended, the engineer may require a joint to be formed in a manner satisfactory to him, so that the fresh concrete, when added, may have a bond. Before depositing fresh concrete the entire surface on which it is to be laid shall be cleaned, washed, brushed and slushed over with grout of cement without sand.

The surface of freshly laid concrete shall be protected from injury in such a manner and for such time as the engineer may require; concrete injured in any manner shall be removed.

Water used in mortar, grout and concrete shall be clean fresh water.

No mortar, grout or concrete which has commenced to set shall be used anywhere in the work. Retempering of mortar or grout which has commenced to set will not be permitted.

Forms for concrete shall be substantial and must preserve their accurate shape until the concrete has set. Where the concrete will show in the finished work, the face of the form shall be built of matched and dressed planking finished truly to the lines and surfaces shown on the plans. Adequate measures shall be taken to prevent the adhesion of mortar to the forms. Forms which have become warped or distorted shall be replaced immediately.

Faces which will show in the finished work shall be true to the form intended, and shall be smooth and free from cavities due to shortage of mortar. Exposed faces shall have a facing of mortar, 2 ins. thick, deposited simultaneously with the corresponding layers of concrete and separated from the concrete by a metal diaphragm of approved form. After the mortar and concrete have been deposited the diaphragm shall be removed and the materials well worked together by spading and tamping, so as to insure their bonding. Plastering the face after removing the forms will not be permitted. The facing mortar shall contain 1 volume of cement to 2½ volumes of sand. Copings and bridge seats shall be finished with a layer of mortar 1 in. thick laid on the fresh concrete, thoroughly worked into its surface and finished smooth to true lines and surface by troweling. They shall be kept damp and protected from the sun and rain for a period of at least 10 days.

Forms shall not be removed until permission has been given by the engineer.

Immediately after the forms are removed, the exposed faces of the walls shall be washed over with a neat cement grout applied with a whitewash brush.

Rock surfaces shall be thoroughly washed and cleaned before concrete is deposited against them, and no concrete shall be deposited in water.

If leaks appear on the surface of the concrete at any time after removing the form, the contractor shall at his own cost and expense, remove the concrete through which the water passes and replace it with sound concrete and shall conduct the water to the base of the wall through channels or pipes in the concrete or take such other measures as the engineer may require.

## THE STREETS AND STREET PLAN OF PARIS; A LESSON IN MUNICIPAL ESTHETICS.

(Editorial Correspondence.)

Paris approaches more nearly to my ideal of what a municipality should provide as ways of communication than any city I have yet seen. The streets are well paved and clean, shaded with trees by day and brilliantly lighted by night. The street plan, with its radial avenues and concentric boulevards, is eminently adapted to quickness of passage from point to point and to impressive views, both distant and near. The many public monuments which mark street intersections and other commanding points of view, the minor statuary and ornamental sculpture along the way, the many public gardens, and the dignified, harmonious and beautiful character of the architecture of the buildings, all combine to produce an aesthetic whole which in America is approached only in Washington. Both of these capital cities owe much of their charm to the deep blue canopy of sky above, their clear atmosphere and brilliant sunshine. London, in comparison, is dingy and dirty. New York, at its best, compares favorably for clearness of atmosphere; but its best days are too infrequent and are growing fewer and fewer with the increased use of soft coal, while Paris, through eternal vigilance, keeps its atmosphere clear in spite of the universal use of that dirty fuel. In wet weather the streets of New York are perhaps cleaner than those of London, but in dry weather the London pavements are cleaner, while whatever the weather the streets of Paris are cleaner than those of either London or New York. But to judge fairly of the condition of London streets, one must remember their comparative narrowness, their crowded condition, and the enormous number of horses which traverse them, a number which seems to be far in excess, taking into account the relative width of the streets, of the number in Paris. As in London, the street traffic in each direction keeps on its own side of the street, so that the pedestrian may cross with more ease and safety than in New York, where the traffic is not so well regulated and where the center of the street is monopolized by fast moving street cars.

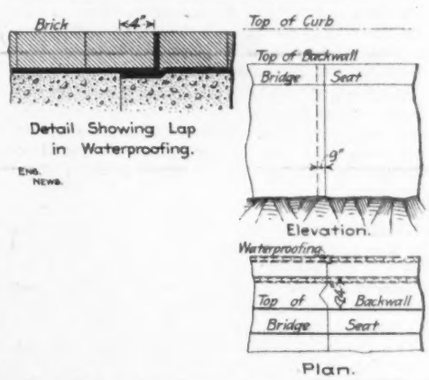



Fig. 5. Details of Expansion Joint in Retaining Wall.

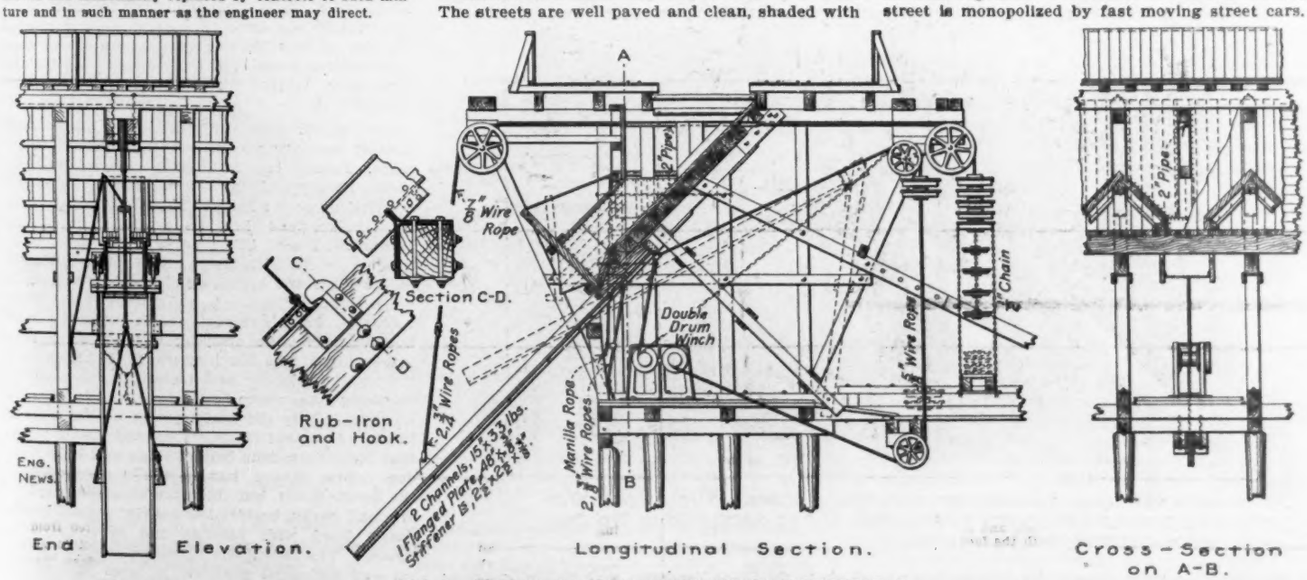



FIG. 6. DETAILS OF DUMPING DEVICE ON PIER TRESTLE.

London has scarcely any surface street railways as yet, while in Paris they are few, and the infrequent cars move slowly. For short distance travel, the number and cheapness of the cabs in London and Paris go far towards making up for the absence of street cars. The average cab horse in Paris, however, is a poor sort of beast, and, in skill, the Paris cab driver compares still less

favorably with the London driver, while his continual cries of warning to other drivers and to pedestrians are amusing when not annoying.

The Metropolitan underground railway in Paris, judging from the crowds which I saw patronizing it, affords a popular means of communication, and the one trip on it which I took and which happened to be in a direction opposite to the bulk of traffic at that hour, was thoroughly agreeable. Both this railway and the "tuppenny tube" in London show by contrast with the old London underground railway how superior electricity is to steam for use in tunnels.

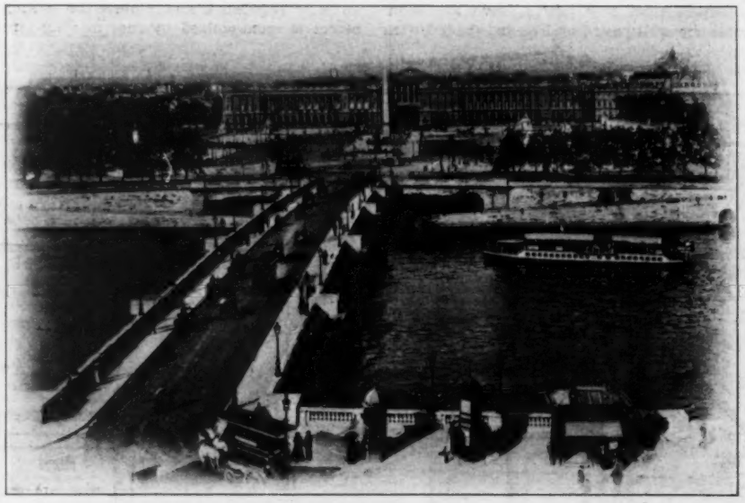
Another and highly pleasurable means of communication is the boats on the Seine. These small boats ply at frequent intervals and make numerous stops. The fare for any distance in one direction within the city limits is 20 centimes, or about two cents.

From the boats or in walking along the quays on each side of the river, one is impressed by the number and artistic character of the bridges of Paris, a feature of the city well known and appreciated by many of our readers. (See Eng News, April 21, 1898.) As may be seen on a map of the City of Paris, there are some thirty bridges across the Seine within the fortifications of Paris.

Turning again to a street plan of Paris, it will be noticed that the city is still encircled with a line of fortifications and that just within is a continuous boulevard or series of boulevards. Some of the other boulevards on the map follow lines of older inner fortifications, marking successive enlargements of the city, and still other boulevards have been constructed independently, either by widening old or cutting new streets. From such a grand center as the Arc de Triomphe no less than twelve avenues radiate, intersecting various boulevards and streets. Coming from the Bois de Boulogne, a large and delightful park outside the fortifications, and just now rich with the colors of late Spring blossoms, we pass through the avenue named from the park, around the imposing triumphal arch, along the famous Avenue des Champs Elysees, through the Place de la Concorde with its obelisk, through the heavily shaded Jardin des Tuileries, with its throngs of men and women and playing children, and on beneath another archway into the Place du Carrousel, which

THE PANTHEON AT THE END OF THE RUE SOUFFLOT.

ment, closing the view just at the point where it begins to weary the eye through monotony or indistinctiveness. The variety and magnificence of the series of views seen in passing from the Bois de Boulogne to and beyond the Hotel de Ville I have just outlined. As an illustration of another sort, note the view as one passes from the Louvre to the Palais Royal and around to the left through the Avenue de l'Opera, the far end of which terminates in the Grand Opera House. Going up to this building, one may stop and look



VIEW FROM THE CHAMBER OF DEPUTIES, SHOWING THE BRIDGE AND PLACE DE LA CONCORDE; THE CHURCH OF THE MADELEINE IN THE DISTANCE, CLOSING THE RUE ROYALE.

is surrounded on three sides by the Louvre, one of the great art treasuries of the world. Going out beneath the archway to the right, one would cross the Seine by the Pont Royal; to the left one would pass out to the Rue de Rivoli and on to the Hotel de Ville, or great city hall of Paris, and still on to the Place de la Bastile and to the Place de la Nation, each with its avenues radiating from monumental piles which mark the street intersections and divert the traffic in various directions, while from the distance they close the vista. This is largely the secret of the charm of the views in the streets of Paris. The eye has something noteworthy to arrest it in every direction. Near at hand are the dignified buildings with their more or less severe but tasteful architectural decorations, and also statues, fountains, trees, flowers and other minor embellishments. In the distance is some stately building or monu-

down to the Place Vendome, with its high column; or going a little further another vista is closed by the facade of the Madeleine.*

It would take me beyond the proper limits of such a communication as this, should I attempt to set forth in detail how the streets and public places of Paris have been made so charming. I can only say—and this, after all, the significant fact for Americans—that this marvelous result has been achieved by intelligent, comprehensive planning, based on the knowledge and love of artistic principles. There is nothing like it in America, except the partially executed plan for Washington, prepared a century ago by the Frenchman L'Enfant, more or less neglected and half forgotten for scores of years, but recently brought to memory and to probable execution by the devoted labors of a group of architects, sculptors and landscape architects at Washington, backed more or less heartily by public spirit in that city and throughout the country.

The artistic needs and opportunities of New York have been persistently and intelligently urged by a similar group of men, but thus far with small promise of immediate, far-reaching results. New York has unique and unexcelled possibilities for esthetic development, some of which have been grasped in a piece-meal fashion; but to ensure unified and harmonious results, it must adopt a complete, definite plan to serve both as an ideal and a model. Imagine Paris losing such an opportunity for civic adornment as was offered the city of New York for so many years by that commanding position at the corner of 23d St. and Broadway where the Flatiron Building now stands!

Some of our American cities have already made notable beginnings in the way of esthetic development. Boston has its Copley Square, with its public library and fine church, and its legislative restrictions on the height of buildings in the vicinity. Indianapolis has its grand circle around Monument Place. Still more notable and far more common in America is the municipal provision of public parks and breathing places, in which many of our cities point the way for the cities of other countries. In this respect, and in the provision of boulevards in the outlying district, New York stands high. The development of its parks, as a matter of landscape architecture, is far ahead of anything I have seen in England, and is certainly not excelled by the park system of Paris. It is in the adornment of its streets and public places that New York falls behind Paris and even London. Paris, indeed, has no parks proper within the fortifications, but there are numerous gardens or small parks, besides the heavily shaded boulevards, lined with benches and decorated with flowers. The Jardin des Plantes combines botanical and zoological gardens. A large part of the area of the former is occupied by long narrow beds filled with classified and labeled plants.

The excellence and cleanliness of the street pavements of Paris are largely due to the fact that the street surfaces are rarely disturbed, and also to the use of hose for cleansing the pavements. Both these features, in turn, are made possible by the immense size of the sewers, the provision for cleaning them, and the location

*To illustrate the above remarks several views of prominent Paris streets and buildings are here reproduced, from originals for which this journal is indebted to the courtesy of the Municipal Art Society of New York.

within them of all pipes for water, gas and compressed air, and of wires for light and power, telephone and telegraph. In all my walking and driving, during a four days' sojourn in Paris, I did not see a single excavation in the pavement. Contrast this with the state of affairs in any American city and one reason for the poorer condition of so much of our American pavement is obvious.

Through the kindness of Mr. Ernest Pontzen,* Cor. M. Am. Soc. C. E., I was introduced to Mr. George Bechmann, Chief Engineer of the sewers of Paris. Mr. Bechmann afforded me every facility I desired for seeing the work under his direction and, among other things, sent Mr. Delfini, one of his assistants, to show me a section of the Paris sewers. We descended a stairway leading to one of the boat-landing pontoons and from the level of the lower embankment entered through a doorway directly to the sewer. Here we boarded a small boat reaching entirely across the portion of the sewer intended for the dry weather flow, and were pushed along for some distance on a short tour of inspection. Overhead on one side was a large cast-iron pipe for potable water, and on the other side was another for conveying Seine water for such purposes as street washing and sprinkling and supplying the public fountains. These pipes were supported from below on iron standards. Stretched along the arch of the sewer were also pipes for gas and for compressed air, and conduits containing electric wires of every description. The character of each class of service was plainly indicated by labels consisting of large white letters on a dark blue ground, and in the lateral house sewers the numbers of the several houses were also placed close by the various house connections. The large water and air pipes looked as though they had been freshly painted and varnished.

Every sewer in Paris is sufficiently large to be entered by men. Altogether, 1,800 men are employed underground, half on the various pipes and wires and half in cleaning the sewers. The sewers are cleaned about once in ten days. In the smaller sewers cleaning is effected by scraping and flushing, through the agency of the sewage itself, which is backed up by means of movable dams. The larger sewers are cleaned by small dredges. The dredge buckets are dumped into a car on a railway track parallel to the dry-weather channel of the sewer. The cars, in turn, are emptied into boats and sent away down the Seine. Large quantities of street dirt and other refuse are also dredged out from receiving pools at the sewage pumping stations.

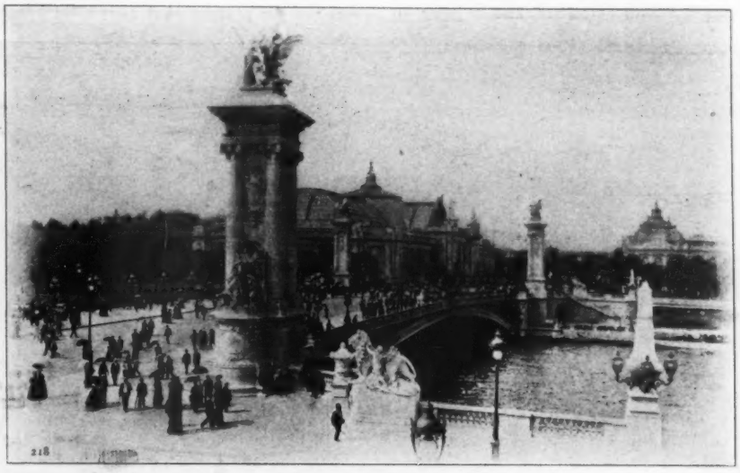
A large proportion of the houses of Paris are still without water closets, but they are rapidly being introduced, and in ten years, it is said, all privies and middens will have been abolished. Excessive storm flows discharge into the Seine. All other sewage is sent to the sewage farms, four in number, with a combined area of 5,400 hectares or 13,338 acres. Two of these farms I visited and of them I hope to write at another time.

It is undoubtedly of great benefit to the street cleaning department of Paris, and to the public, to have the street dirt flushed into the sewers, as it aids greatly in keeping clean both the streets and the air above them. Without the large sewers and the cheap supply of Seine water the plan would not be feasible, but the combination of these two features and the utilization of sewers as subways for pipes and wires is most unique and interesting. Probably such a combination would not be practicable in America, but of the desirability of providing subways for pipes and wires, thus rendering both pipes and wires readily accessible for repairs, and obviating the necessity of tearing up expensive pavements as soon as put down and ruining them by repeated excavations, there can be no doubt. Will the great city of New York allow all its underground railway system to be built without seizing so good an opportunity to render some of its underground furniture as accessible as that of Paris?

M. N. B.

Paris, May 6, 1904.

*65 Rue Monceau, Paris.



THE ALEXANDER III. BRIDGE.

THE AVENUE DE L'OPERA, WITH VISTA CLOSED BY THE OPERA HOUSE.

## CONCRETE MIXER WITH AUTOMATIC MEASURING DEVICE.

We illustrate herewith a new type of concrete mixing machine of the continuous type, in which the ingredients are automatically measured and fed in small quantities. It is the invention of Mr. Henry Campbell, of Milwaukee, Wis. It is termed the "Autometric" concrete mixer, and is being introduced by Campbell & Marsh, 47 Cawker Building, Milwaukee, Wis. Two of these machines are now in operation at the works of the Memphis Hydraulic Stone Works, Memphis, Tenn.; and the Iowa Hydraulic Stone Co., Fort Dodge, Ia.

In considering the requirements of concrete making, it occurred to Mr. Campbell that the machine should measure the aggregates, feed them into the machine, mix them dry, apply the water, mix them wet, and discharge the finished product, doing all these things automatically, but strictly in accordance with the requirements of the engineer in charge of the work. While the machine is of the continuous type, it is said to be free from the objections sometimes raised against other machines of this type. The mixing is accomplished in much the same manner as in the best type of intermittent or batch mixers, but more effectively, it is claimed, because the materials are introduced into the machine in small quantities and also because they are always first mixed while still in a dry state.

As the ingredients are supplied to the ordinary batch mixer, each batch receives a quantity of cement which is dumped into the machine in one mass. A large amount of agitation is therefore necessary to secure satisfactory mixing. With the "Autometric" machine the cement is introduced steadily in small quantities of only a few cubic inches each. It mingles at once with small masses of the other ingredients introduced in the same way. Much less agitation is necessary to secure the same amount of mixing as in a batch machine, or with the same amount of agitation the mixing is more thorough. The different ingredients are equally distributed throughout the mixer, and the concrete or mortar produced is uniformly and thoroughly mixed.

With some mixers, the dry mixing is either performed outside the machine by hand, or omitted altogether. If the dry mixing and the wet mixing are effected in the same chamber, a portion of the dry cement striking the walls coated with wet material forms nodules of neat cement and is thus prevented from being uniformly distributed throughout the mass. Another portion also clings to the wet sides of the mixer and necessitates the frequent cleaning of the machine, often a difficult and tedious process. With the "Autometric" mixer, the dry mixing is effected in a dry chamber, the forward half of the cylinder being devoted exclusively to this and the measuring features.

While much is claimed for the machine as a mixer, its automatic measuring device is perhaps its most distinctive feature. The machine consists essentially of a horizontal revolving cylinder, with suitable driving mechanism, and a hopper for storing a supply of the materials. The cylinder is closed at the receiving end by a head having a spur gear on the rim and is carried on a hollow journal. The discharge end is entirely open for

the free egress of the concrete. The hopper is detachable and is partitioned off internally in about the proportion in which the three ingredients are used. These ingredients fall by gravity from the hoppers into troughs located beneath and concentric with the receiving end of the cylinder. Three sets of buckets or scoops of known capacity, one set for each of the different ingredients, are attached to the outer surface of the cylinder. As the cylinder rotates, these buckets pass through the troughs, fill with materials, and as they approach the top, discharge by gravity into the interior. Means are provided to prevent the buckets from taking up any excess of material. By this means an accurate measurement is secured. Blanks can be substituted for as many of the buckets as desired; and by a simple device the capacity of any individual bucket can be varied. The opportunity is thus given of changing the relative proportions of the ingredients as desired. Spouts project into the interior of the cylinder from the bucket openings and are of such shape as effectually to trap the materials and prevent their egress. This trapping is aided by deflecting conveyors, which also assist in the dry mix and in feeding the materials toward the discharge end of the cylinder.

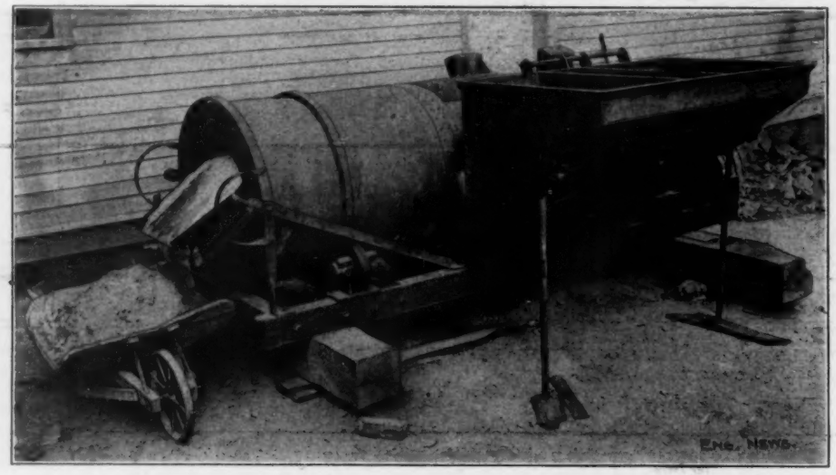



FIG. 1. CONCRETE MIXING MACHINE WITH AUTOMATIC MEASURING DEVICE.
Campbell & Marsh, Milwaukee, Wis.; Builders.

In Fig. 1 is shown a 15-yd. mixer on skids, with hopper, discharge chute, etc. Fig. 2 is a transverse section through one of the sets of buckets. The bucket, A, at the bottom is empty, the one at the top, B, is just discharging the last of its contents into the cylinder. The one at the right is shown, first (at C) as emerging from the trough heaped up, and again (at D) after the excess of material has been scraped off by the leveling device. This strike-off, or leveler, is provided with two projecting pins on each side, working freely in curved slots. The curvature of the slotted guides is not concentric with the cylinder, but the guides are so set that as the bucket rises, carrying with it a surplus of material, it forces the strike-off upward and outward across the upper edge of the advancing bucket. The strike-off, following the curved slots in the guides, is forced away from the cylinder until it finally clears the bucket entirely, when it drops back to its normal position ready for the next ascending bucket. The impact of the drop is taken up by rubber buffers at the bottom of the slots. The bucket, after leaving the strike-off, rises to nearly the vertical line of the cylinder, where it discharges through the interior chutes into the inside of the drum, as shown. The lower part of Fig. 3 is a longitudinal section showing the curved blades, etc. The upper part is a developed plan of the inside. This cut shows the relative location of deflectors, pick-ups, interior chutes at the bucket openings, etc. In very large machines more buckets and chutes are used than are here shown.

After the materials have passed the last set of buckets, in addition to the deflecting conveyors they are subject to the action of pick-ups or blades attached to the inner surface of the shell parallel with its axis. Here the dry mixing is completed and the material encounters the water. This is let in through a pipe which passes through the hollow journal on the head at the receiving end of the cylinder. The flow can be regulated by a valve outside. From this point to the discharge of the finished concrete the material is continuously picked up and dropped till it finally reaches the open end of the cylinder. Here a tilting discharge chute projecting into the interior receives the product as it falls from the pick-ups near the top of the rotating cylinder, and delivers it at a height of 28 ins. from the ground. This chute can be tilted to stop the flow of the concrete while removing one barrow or other receptacle and placing another, thus rendering the delivery continuous or intermittent at will.

A machine that will produce 15 cu. yds. per hour has a cylinder 3 ft. in diameter and 7 ft. 8 ins. long, making 12 revolutions per minute. Half the length of the cylinder is devoted to the measuring and the dry mixing. All machines of capacity up to 7½ cu. yds. per hour are provided with a detachable steel hopper for the storage of the material to supply the machine. It can be removed and replaced in a few minutes. The top of this hopper is 4 ft. 8 ins. from the ground. With larger machines no hopper is furnished, unless called for, as it is expected that a more commodious hopper of wood will be constructed on the job. Suitable means are provided for attaching such a hopper to the troughs. The machines are made of various capacities from 2 to 30 cu. yds. per hour. The power required to run this machine is claimed to be about half that required to run an ordinary batch mixer of the same capacity. With the latter the inertia of a large charge has to be instantly overcome, while the engine or motor is practically idle between batches, and must have sufficient power to do double duty while the batches are in the mixer. It must also be large and strong enough to withstand the strain of the sudden load. With the "Autometric" machine the load on the engine or motor is steady and uniform, with a relatively small amount of material passing continuously through the machine.

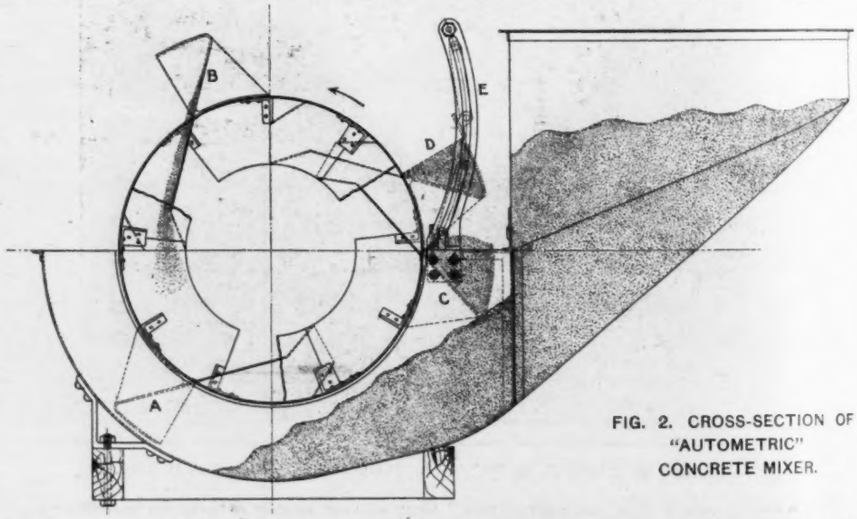



FIG. 2. CROSS-SECTION OF "AUTOMETRIC" CONCRETE MIXER.

The following is a summary of the more important points of advantage claimed for this machine: (1) It measures the ingredients, and then mixes them thoroughly; first dry, then wet. (2) It consists practically of but one moving part, the rotating cylinder. (3) The ingredients and processes are in plain sight; the measuring on the outside of the cylinder, the dry and the wet mix on the inside through the discharge end. (4) It is impossible to slight either the measuring or the mixing. (5) Every portion of the process is readily under the control of the attendant, is entirely automatic, and is independent of the carelessness of incompetent laborers. (6) The best concrete is produced with a minimum of motive power for the amount of work done and of output; a minimum number of laborers, because of the automatic nature of all processes; a minimum of cement, because of the careful measurement and the thorough admixture; and consequently at a minimum of cost. Special advantages are claimed for the machine in such work as making concrete building blocks. In a factory of this kind the storage hoppers could be constructed of extra large capacity and supplied directly from cars or wagons, while the finished concrete could be discharged directly into the molds, as slowly or as rapidly as desired.

## SOME LESSONS OF THE BALTIMORE CONFLAGRATION.

An interesting report on some of the lessons of the Baltimore fire has been submitted to the Insurance Engineering Experiment Station by Prof. C. L. Norton, Engineer in Charge and Mr. Joseph P. Gray, Consulting Engineer. This report is published in a recent bulletin from the experiment station, and we reprint herewith its principal parts:

A study of the conditions prevailing in the portions of Baltimore which were recently destroyed by fire, and of the structures in this district after the fire, leads to two general lines of suggestion for future safety of similar districts in cities now built or to be built. The first thought that occurs to one in looking over the situation is the similarity of conditions prevailing in almost all large cities in the matter of lack of preventive measures in retarding fire spread from building to building, the lack of protection against exposure hazard. The second thought brought home by the towering remains of the tall steel-frame buildings is the failure of the word "fireproof" to give any proof of its right to exist as applied to such buildings.

The danger of spread of fire through the whole of such a district needed no new emphasis. Boston, Chicago, Paterson, and other cities had shown that none of the pre-

ventive measures in use in such cities would avail against a fire started during a gale of wind in a district composed largely of buildings of inferior construction. What happened in Baltimore is likely to happen in New York or Boston if once a fire gets well under way. The danger is not so great, perhaps, in some other cities as it was in Baltimore, but its presence must be admitted.

The measures to be adopted to prevent the possible conflagration spread in cities have been enumerated by abler pens than mine, but I will venture upon a few suggestions: First, remove from these crowded cities the greatest cause of quick spread of fire, in the shape of explosive material. It has been said that explosions of chemicals occurred in the early part of this fire, but whether or not this was really the case or whether there was a series of so-called hot-air explosions from the products of distillation, it seems clear that something in the nature of an explosion scattered the fire.

As is well known, the products of distillation in a slow fire smoldering for some time before becoming rapid in its spread, may, when mixed with air, become explosive. The opening of a door or breaking of a window may cause a draft that leads the flames toward the smoky mixture and starts the explosion, known to the firemen as a "hot air" explosion. Sprinklers and ventilation and stops in vertical openings tend to minimize this danger.

Stringent laws against storing explosive merchandise and care in installing ventilation systems, thermostat systems and sprinklers will tend to minimize the danger of early spread of fire by explosion.

Unless violently scattered as by an explosion, fire spreads through such a district by the carrying of sparks, by direct contact of flame, and by radiation across open spaces. Protection against all these dangers is to be sought by means of non-inflammable roof materials, shutters and wired glass, in metal or metal-covered frames for all openings, and roof hydrants.

Fire has apparently in this case found its way from building to building through doors and windows and through roofs which offered but slight resistance. There were buildings in this district equipped with tinned and sheet-iron shutters and some with other protective devices, but few or none withstood against the enormous volume of flame and hot gases coming from the majority of partially protected or unprotected risks. There is nothing new in this, but it is a condition so common and so dangerous as to bear repeated references.

I am satisfied that with roof hydrants having a good supply of water, and the universal use of wired glass and tinned shutters and metal-covered sash in this district, the Baltimore fire of 1904 had been relatively a small conflagration. And, further, the systematic use of these three preventive appliances and sprinkler systems in other cities where they are not in use would greatly decrease the conflagration risk.

The second and more interesting line of suggestion comes from a minute study of the condition of some seventeen so-called "fireproof" buildings in the burned district. Some of these are untouched. Some are ruined. Some are sadly damaged. Let us see why their conditions are so different, and why some fared so badly.

It is apparent at once that some of the buildings are intact in large part because of their having been less vigorously attacked by the fire than were the others and for no other apparent reason. These buildings being low, surrounded by taller neighbors, or situated on street corners, seem to have been actually jumped over by the wave of combustion. There is ample evidence that the outside of these buildings did not rise in temperature to the igniting point of wood or paint. On some of them not even the skylights are broken, and an almost incredibly small amount of damage was done to their exterior. In most cases the buildings may be said to have been without a severe fire trial.

A second group of fire-resisting buildings includes those which have been well described by the word "monumental." The Court House and City Hall offer examples of this type, being heavy stone buildings, with comparatively few window openings. Offering a small area for the entrance of fire and a non-inflammable exterior, these buildings withstood great heat, with no damage except from the spalling of the stone and charring of window frames. It should not be assumed, however, that the fire was driven toward these buildings with such fury as that which it expended on some of the steel-frame buildings, as accounts indicate that a change in the wind diverted the fire from them at the most opportune time. On the whole, these monumental buildings demonstrate the effectiveness of a minimum window area in reducing the danger of ignition rather than anything else. They further call attention to the frailty of stone. The modern steel-frame construction, popularly called "fireproof," was exemplified by some half-score of buildings in the edge and center of the burned area. These buildings furnish material for much study, and, from their defects as here demonstrated, I have no doubt that we may learn much that will go far to prevent even the partial destruction of such buildings built in the future.

The general condition of the steelwork itself is apparently good, except in a few instances. Neither the fire, nor corrosion preceding the fire, has sensibly affected it, if we may judge from its appearance. The "fireproof" buildings of steel-frame construction show in general failures along the same lines. Where the walls are substantial and of good red brick, they stood the test fairly well. There was some spalling and in some cases a crumbling, but good red bricks seem to have lined up to their earlier reputation. Where brickwork of a higher color, ornamented with terra cotta, was used, considerable more damage was noticeable, especially after the slight snow storms of the week following the fire. Stone trimmings, almost universal on the lower fronts, demonstrated the unfitness of that material beyond all question. Granite, marble, sandstone, and limestone all fared about alike, even when, as near as can be ascertained, very little or no water was thrown upon it. In general, all outside wall material suffered, but brick much less than the rest.

It has already been said that the steel frames themselves appeared in good condition. Exceptions to this may be found in the Equitable Building and in the upper stories of some of the others. None of these frames, however, collapsed and none are likely to do so, though some posts and beams were bent or crushed and some will need to be replaced in nearly every one of the steel-frame buildings. The light steel frame of the somewhat older Equitable Building is seriously injured and a considerable amount of reconstruction is needed here. Posts are bent and sagged and beams are badly deflected. It is probable that this light frame was subjected to a great strain from the falling of the safes after the plank top floor burned through, the arches of terra cotta not being strong enough to carry their weight.

The steel frames will need careful examination to note possible distortion or weakening. In general, the frames are not injured by more than 10%, and in some cases by a much less amount, though in the Equitable Building the loss to the steel would seem to be between 50% and 75%, or even more.

The posts and beams in about all these buildings were covered either with terra cotta or with "lime-teil," a material whose composition appears to be in the nature of a plaster and cinder mixture. Generally the covering served its protective purpose well, but was itself destroyed or badly damaged. A very large percentage of the terra cotta and lime-teil block must be replaced, and it is the general, almost universal, condition that the beam covering of the flanges is gone. The loss of terra cotta beam and post coverings was at least 75%.

The partitions of terra cotta and lime-teil are very largely destroyed and the unfitness of these materials for this purpose seems clear. Many partitions have fallen and more are in such condition that they must be replaced. Much of the lime-teil is softened and the terra cotta is cracked or broken and the bond between blocks is loosened. If metal lath partitions were in existence to any great extent, they failed as well, for few were in evidence in good order.

The floor arches of many different spans and of different details of construction, but in the main of terra cotta or lime-teil, show much the same sort of distress as the partitions. The bond between the tiles is broken, quite generally, and the tiles themselves are cracked and broken in great numbers. The lower face or soffit of the tiles has split off very large areas, and 50% or 60% of the terra cotta floor construction will, I fear, need to be replaced or reinforced.

Where concrete floor arches and concrete-steel construction received the full force of the fire it appears to have stood well, distinctly better than the terra cotta. The reasons I believe are these: First, because the concrete and steel expand at sensibly the same rate and hence when heated do not subject one another to stress, but terra cotta usually expands about twice as fast with increase in temperature as steel, and hence the partitions and floor arches soon become too large to be contained by the steel members which under ordinary temperature properly enclose them. Under this condition the partition must buckle and the segmental arches must lift and break the bonds, crushing at the same time the lower surface member of the tiles. Especially in the Calvert Building, I found evidence which leads me to believe that not an excessive temperature, but the differential expansion under a moderate high temperature of the terra cotta, of the top and bottom members and of the enclosing steel, is responsible for the general failure of the terra cotta partitions, beam-covering, and floor arches. Secondly, Mr.

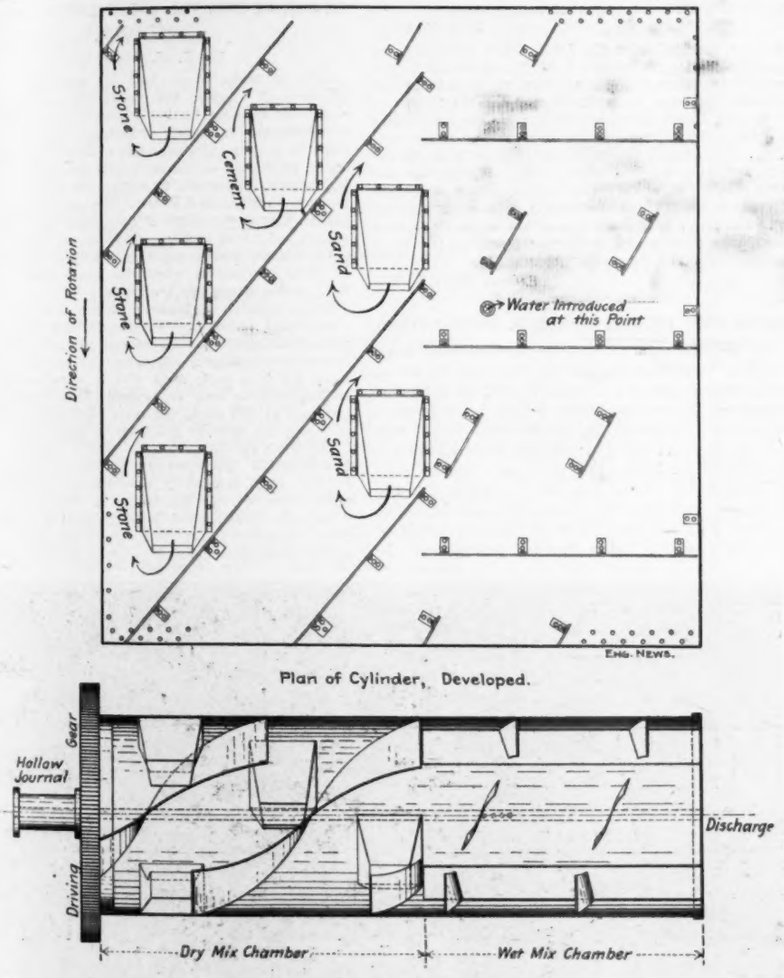



FIG. 3. LONGITUDINAL SECTION AND DEVELOPED INSIDE PLAN OF "AUTOMATIC" CONCRETE MIXER.

Gray suggests that there is a similar unequal expansion of the top and bottom faces of the separate tiles, which causes the lower faces to expand and shear off. Evidences of this were found everywhere.

Further examination of the expansion phenomena points to them as the main source of distress to the whole beam and post covering, floor, arches, and partitions. Most of the fallen terra cotta partitions and the floor blocks were still hard and had a clear ring when struck, though cracked and broken. There was no evidence of any such temperature as that at which the terra cotta had been baked originally, and the material of the blocks could not have been altered chemically. It will be readily understood that the thin walled hollow tiles would become heated upon one side much more quickly than would the equivalent area of a solid partition of brick or concrete. Terra cotta, cinder concrete and stone concrete all have about the same heat-absorbing power, or specific heat, and hence the heavier and more solid the partition or floor; in other words, the more material there is in it, the slower will be its rise in temperature and its subsequent expansion.

I question whether any floor, containing so little material on its outer faces as did these hollow blocks, could remain sufficiently cool in this fire to avoid serious injury from expansion.

The minor details of the structure and finish fared badly. Wood is not in evidence except in secluded corners. Marble, slate, plaster, and in fact all similar surfacing material suffered to the point of destruction. The cast-iron stair frames and rails stood remarkably well in most instances.

The building of United States Fidelity and Guarantee Co. is an interesting example of reinforced concrete in the district. As near as I could ascertain, it was subjected to a severe fire and I found evidence of temperatures up to the softening point of cast iron. The condition of the lower part of the structure and apparently of the whole structure showed the great fire-resisting powers of this type of building. It is of especial interest in that the Experiment Station made a preliminary test on an arch of this same type and of almost this exact thickness and span and weight of metal, which failed because of the slender 6-in. posts, and not through the failure of the floor, at the end of three hours and forty minutes' exposure to a 1,700° to 2,000° F. fire.

Further, in the International Trust Co. Building a small paper room having a Hennebique floor and ceiling, was so intensely heated that at the end of three days the lumps of cast iron which had earlier been a copying press and an embossing stamp were still red hot, and yet neither floor nor ceiling show signs of distress. This is the more remarkable in that the walls of the adjoining building fell through the skylight upon the Hennebique floor. There were in the Commercial and Farmers' National Bank and in the National Bank of Commerce concrete floors which stood the fire test well.

The general condition of the fireproof building is such as to indicate to my mind the unfitness of terra cotta for beam and post covering and floor construction as here used when compared with concrete or brickwork. Second, there is no evidence that the tall steel building was subjected to an unusually severe test. While it must be admitted that not enough concrete received the full effect of the fire to make the test a perfectly complete one, when I add to this the experience of several years in examining the action of fire upon concrete, I am convinced that had the floors of the Continental Trust or the Calvert Building been of any one of the better class of concrete types and had the beams and posts been encased in 4-in. coatings of sound concrete their renewal would have required little but plastering.

Little difference in the action of the fire on stone concrete and cinder concrete could be noted, and as I have earlier pointed out, the burning of the bits of coal in poor cinder concrete is often balanced by the splitting of the stones in the stone concrete. I never have been able to see that in the long run either stood fire better or worse than the other. However, owing to its density the stone concrete takes longer to heat through. When brick or terra cotta are heated no chemical action occurs, but when concrete is carried up to about 1,000° F. its surface becomes decomposed, dehydration occurs and water is driven off. This process takes a relatively great amount of heat. It would take about as much heat to drive the water out of this outer quarter-inch of the concrete partition as it would to raise that quarter-inch to 1,000° F. Now a second action begins. After dehydration the concrete is much improved as a non-conductor, and yet through this layer of non-conducting material must pass all the heat to dehydrate and raise the temperature of the layers below, a process which cannot proceed with great speed.

Much has been said about the uncertainty of concrete. The value of concrete in theory is often admitted by those who consider it unwise to use it because of the difficulty of getting the materials properly proportioned, mixed, and placed in position. I have never been able to see the force of this. It is quite as easy to lay sound concrete as it is to put somewhat irregular and confessedly brittle blocks of terra cotta into place with proper bonding. The main difference seems to be that poor concrete reveals its weakness when it falls on "pulling the centers," while terra cotta is likely to be strong enough to hold itself in position even when it can do little more. Further, a prolonged search revealed only occasional evidence of temperatures as high as 2,400° F. and no instance could be found of real fusion of terra cotta or brick in them. Occasional evidences of temperature of 2,200° F. were found, but in general there was ample evidence that the temperature of the fire in these buildings had never in most places risen above 1,700° F. This is likely to happen in almost any office building where little care is taken as to the nature of its contents and must be provided for if these buildings are to be proof against the combustion of their own contents.

It seems apparent that, with care, steel frame buildings can be so constructed as to stand the destruction of their contents without injury to the steel and probably without danger to the protecting material or floor arches; that, with shutters and wired glass, the burning of more combustible neighbors may be expected to cause little permanent injury to the structure proper; and that a district composed wholly of such buildings would be reasonably immune from danger of conflagration.

C. L. Norton.

On the week following the fire I visited Baltimore and spent the greater part of two days' time in examining the result of the fire on the different types of construction and studying its effects, as far as it was possible for me to do in that length of time. My conclusions are similar to those of Professor Norton's and with some slight variations, which would not affect the main body of the report, I heartily approve of the same. I especially approve of that part of the report relating to the advantages of concrete construction, basing my opinion on observations made not only at this fire, but at previous ones which have occurred in buildings of concrete and other types of so-called "fireproof" construction.

J. P. Gray, C. E.

## ARCHED ROOF TRUSSES OF TIMBER CONSTRUCTION.

The use of timber trusses for roofs of large span is now a rare practice, but we illustrate herewith the construction of an arched roof with timber trusses of 76 ft. clear span, which is of interest not only for its design, but for the fact that it was built in the short space of four weeks in November and December, 1902. This structure is the "Amphidrome," at Houghton, Mich., built by the Houghton Warehouse Co. as an ice rink in which to play the Canadian game of hockey, which is now being rapidly taken up as a winter game in the northern States. Fig. 1 is an interior view of the completed structure.

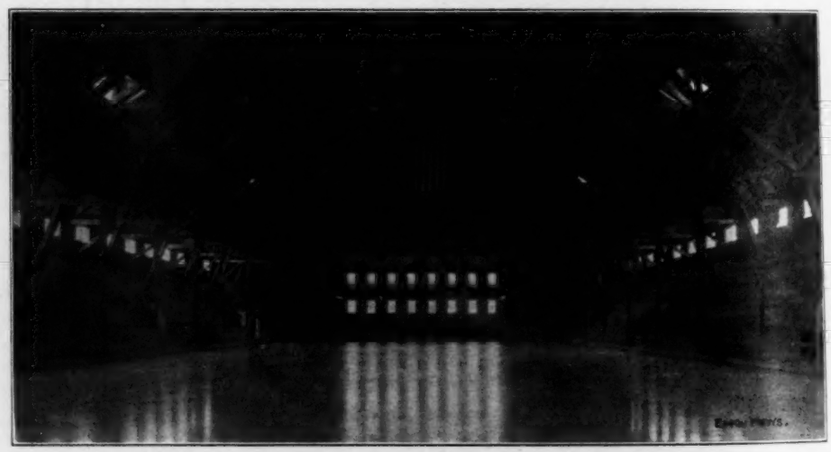


FIG. 1. INTERIOR OF THE AMPHIDROME AT HOUGHTON, MICH.; WITH WOODEN ROOF TRUSSES.

J. F. Jackson, Assoc. M. Am. Soc. C. E., Engineer.

The building is 225 × 104 ft., with an ice floor 76 × 180 ft. On each side of this floor are five rows of seats, rising at an angle of about 45°. Seats are also provided at each end. It is said that 2,800 people have been accommodated in the building at one time. The roof over the main part of the building is carried by ten arched trusses, 16 ft. c. to c., the design of which is shown in Fig. 2. These were built on the floor and hoisted into position. It will be noted that if the arch is assumed to terminate at A-B, the thrust is carried down to the ground by three complete triangles. There are no bottom tie rods, but the cedar foundation timbers are all drift-bolted together and are partly embedded in the ground. Fig. 3 shows the construction at the west end, and the arch trusses. The trusses, columns, purlins, etc., were all built of pine timbers 2 × 8 ins., 2 × 8 ins., 2 × 10 ins., and 3×6 ins., obtained from a local lumber yard. They were put together with spikes, but in the trusses two ⅞-in. bolts were put in at each joint, in addition to the spikes.

No stress diagrams were prepared, owing to lack of time, but it is stated that the structure has withstood one exceptionally heavy wind storm and has carried very heavy snow loads during the two winters that it has been in use. For particulars and drawings we are indebted to Mr. J. F. Jackson, Assoc. M. Am. Soc. C. E., of Houghton, Mich., who designed the structure and superintended its erection.

## AN INQUIRY INTO THE WORKING OF VARIOUS WATER SOFTENERS.*

By C. E. Stromeyer.†

Scale on boiler plates does not materially reduce the efficiency of a boiler, but it seriously increases its wear and tear, whereby its life is considerably reduced. It also endangers the safety of boilers. The same remarks apply to coatings of grease due to feeding the boiler with water containing condensed steam from the engine. It is, therefore, desirable to remove all scale-forming impurities from the feed-water. These impurities are suspended matter, carbonate of lime, sulphate of lime, magnesium salts and grease. One has also to be on one's guard against introducing large quantities of soluble salts, as these concentrate when the water evaporates, until thick scales of crystals are formed.

Let us examine the behavior of these various impurities.

Suspended matter is often organic, and appears to have a beneficial effect on such mineral precipitates as may be formed by combining with them and forming loose sediment, which is easily dealt with in water softeners, or it settles down as mud in boilers. Some suspended matter, such as fine sand, and more particularly paper pulp, settles on the furnaces and leads to collapses.

CARBONATE OF LIME IS THE CHIEF CAUSE OF TEMPORARY HARDNESS.—Its chemical formula is $CaCO_3$. It is practically insoluble in water, but it is easily converted into bicarbonate of lime, having the formula $CaH_2(CO_3)_2$, which is fairly soluble in cold water, and is a constituent of most natural waters. Its second equivalent of carbonic acid is easily removed on boiling, when of course the carbonate of lime is precipitated, forming a scale. The slower this reaction is carried out, the slower the heating, the more chance is there for this carbonate of lime to form crystals—called calcite in mineralogy—which constitute a fairly hard scale, as found in economizers, where the conditions are very favorable to its production. This explains why, in the south of England, where the waters contain much temporary hardness, economizers are very little used, for they would get choked unless the waters be first softened. Waters poor in carbonate of lime but rich in sulphates do not choke the economizer pipes. If the heating is effected rapidly, as for instance when natural waters are pumped direct into the

*Extracts from a paper read before the Institution of Mechanical Engineers of Great Britain.

†Manchester Steam Users' Association, Manchester, England.

steam space of a boiler, the precipitation of carbonate of lime is so rapid, that only a mud is formed. Another means of converting bicarbonate of lime into carbonate of lime, is to add solutions of caustic lime, burnt lime, or caustic soda, in water. The chemical reaction is as follows:

| Bicarbonate of Calcium | + | Caustic Lime | = | Carbonate of Lime | + | Water |
|---|---|---|---|---|---|---|
| $Ca H_2(CO_3)_2$ | + | Ca O | = | 2 $Ca CO_3$ | + | $H_2O$ |
| Soluble | | Soluble | | Insoluble | | Water |

The second equivalent of the carbonic acid in the bicarbonates of lime and of magnesia is generally called half-bound. Any excess is called free carbonic acid. Of course sufficient lime is required to neutralize both.

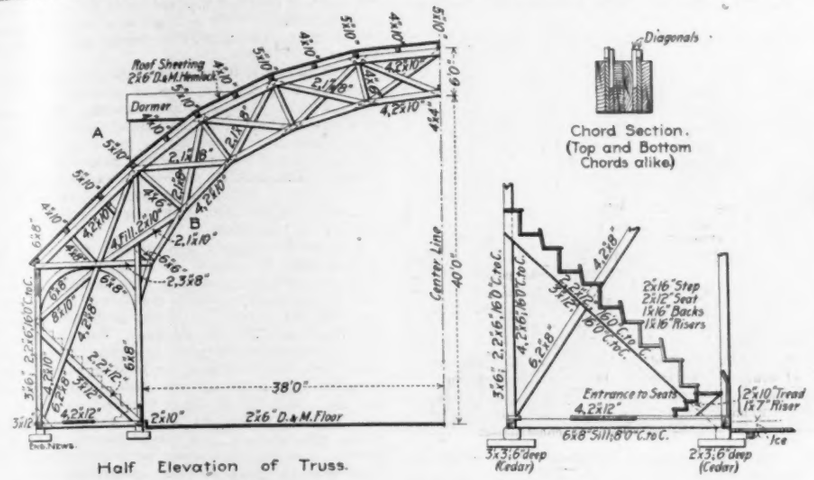



FIG. 2. DETAILS OF TIMBER ROOF TRUSSES OF THE AMPHIDROME.

Fig. 4. Detail of Seats.

SULPHATE OF LIME.—The chemical formula is $CaSO_4$. It is fairly soluble in waters up to the boiling point at atmospheric pressure, but it is less soluble at temperatures corresponding to high pressures of steam. Because this sulphate of lime cannot be removed by ordinary boiling it is called permanent hardness. One grain of sulphate of lime equals 0.7350 permanent hardness. The result is that if waters containing sulphate of lime are pumped into a boiler, the constant evaporation effects a slow concentration until saturation point is reached, when the sulphate of lime is precipitated so slowly that it crystallizes and adheres to all parts of the boiler, but more particularly to the hottest parts; then, whenever the pressure drops—and with it the temperature—part of the precipitate is redissolved, the spaces between the crystals are filled with concentrated solutions of sulphate of lime which crystallizes out again on heating, whereby the originally small and loose crystals are enlarged and are firmly cemented together, forming a very hard scale, which can only be removed by chipping or by heating; it is practically gypsum or selenite. If any carbonate of lime is mixed up with the scale, this too gets thoroughly cemented with it.

At the temperatures corresponding to high pressures, water can dissolve only about 20 grains of sulphate of lime per gallon. On cooling down a boiler and letting it stand for some time, the water will dissolve parts of the crystals until there are about 170 grains to the gallon. This dissolving action loosens the scale, which can be easily removed as long as it is wet. If the scale be allowed to dry, all the 170 grains of sulphate crystallize and thereby cement together the loose parts of the scale, making it hard and difficult to remove.

The principle of pumping feed-water into a trough in the steam space of a boiler has several times been patented, but as boiler water can hold up to 20 grains of sulphate of lime in solution, this method is of no benefit with waters having less permanent hardness than 15°.

The sulphate of lime can always be entirely removed by conversion into carbonate of lime. The reaction is as follows:

| Sulphate of Lime | + | Carbonate of Soda | = | Carbonate of Lime | + | Sulphate of Soda |
|---|---|---|---|---|---|---|
| $Ca SO_4$ | + | $Na_2 CO_3$ | = | $Ca CO_3$ | + | $Na_2 SO_4$ |
| Soluble | | Soluble | | Insoluble | | Soluble |

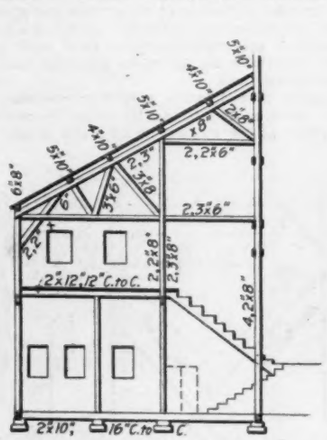
If there is any free or half-bound carbonic acid in the water, and this is generally the case, caustic soda, if available as a waste product, may be used. The caustic soda combines with the carbonic acid to form carbonate of soda, and the reaction is then as sketched above; and the lime which has lost its one equivalent of half-bound carbonic acid is also precipitated. Caustic soda without carbonic acid will not precipitate the sulphate of lime. It is, therefore, wrong to introduce caustic soda into boilers which are fed with water having only permanent hardness. In fact, caustic soda should not be pumped into a boiler except together with the cold feed, for as long as the water is cold, the carbonic acid can be fixed, and additions of caustic soda would come too late if made in the boiler.

The above sketched chemical reaction can easily be carried out in water softeners, but the separation of the precipitate is as slow as in the last case, and unless heat is applied, the newly-formed carbonate of lime has to settle for a long time.

MAGNESIUM SALTS.—These are found in natural waters as nitrates, chlorides, sulphates, and cause permanent hardness, or as bicarbonate which causes temporary hardness; they are very soluble except the last-named. They all react on soap, and heat will not precipitate them, except the bicarbonate by driving off its carbonic acid. At the high temperatures to be found in boilers a reaction resulting in precipitation of magnesia takes place between the carbonate of lime and the soluble magnesium salts. The bicarbonate of magnesia can be partly removed by converting it into carbonate of magnesia by the addition of caustic lime.

The reaction in water softeners is as follows:

| Bicarbonate of Magnesia | + | Caustic Lime | = | Carbonate of Magnesia | + | Carbonate of Lime | + | Water |
|---|---|---|---|---|---|---|---|---|
| $Mg H_2 (CO_3)_2$ | + | Ca O | = | $Mg CO_3$ | + | $Ca CO_3$ | + | $H_2O$ |
| Soluble | | Soluble | | Slightly Soluble | | Insoluble | | Water |



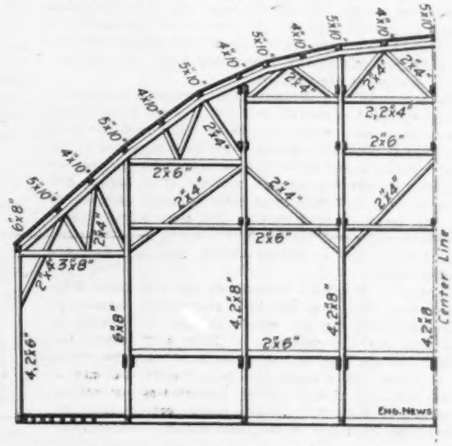




FIG. 3. END FRAMING OF AMPHIDROME.

The last traces of magnesium carbonate are removed by adding an excess of lime, the reaction being as follows:

| Carbonate of Magnesia | + | Caustic Lime | + | Water | = | Hydrate of Magnesia | + | Carbonate of Lime |
|---|---|---|---|---|---|---|---|---|
| $Mg CO_3$ | + | Ca O | + | $H_2O$ | = | $Mg (OH)_2$ | + | $Ca CO_3$ |
| Slightly Soluble | | Soluble | | Water | | Insoluble | | Insoluble |

The other magnesium salts react in a similar way, being easily converted into carbonate and hydrate by the addition of burnt lime and soda ash.

The carbonate of magnesia, $MgCO_3$, is very slightly soluble in water, whereas the hydrate of magnesia $Mg(HO)_2$, is practically insoluble, but being a gelatinous mass it causes serious difficulties in water softeners, more especially by clogging the filters.

GREASE.—This is, of course, only found in the waters discharged from jet or surface condensers or from feed-heaters in which steam is condensed. Vegetable and animal fats cause corrosion in boilers, but as they are unsuitable for cylinder lubrication, they are now rarely used and heavy mineral oils have been found to be more suitable. Modern marine practice tends towards the running of engines without any cylinder oil, but factory engines still consume large quantities, and thereby contaminate their feed-water if drawn from the condenser. Part of this grease floats on the water and could be removed by filtration; probably it does little harm if it gets into the boiler, but a small trace is emulsified in the water and is very difficult to deal with. It cannot be separated from water by boiling at atmospheric pressure, but it is completely removed by the conditions which exist in a boiler, and as it adheres to the heating surfaces it causes overheating, which may result in a collapse and certainly increases the wear and tear.

The peculiarity of grease deposits in boilers is that their effect is out of all proportion to their thicknesses. Scale of ¼-in. thickness will raise the temperature of furnace plates about 300° F., and as grease offers ten times more resistance to heat, one would expect that 1-80-in. would have the same effect as this thickness of scale, but experience shows that the merest trace of grease, certainly less than 1,000th inch, or one-tenth of the above, can cause far more serious injury than scale. Various explanations have been attempted. According to one of these, thin films of grease form tough bubbles on the heating surface and prevent the water from keeping it cool. Another view is that grease, either alone or joined to mineral matter, forms an impalpable powder like oxalate of lime and other precipitates, and, like these, retards ebullition. In support of these views we find a fairly well-founded belief that grease in boilers is more injurious if these boilers are clean than if they are coated with mineral scale, and against this view we have the undoubted experience that land boilers with scale at once give trouble if condensed water is used instead of natural water. Increase of pressure above 110 lbs. seems to accentuate this evil; perhaps this may be due to decomposition of magnesium carbonate when this temperature is reached. In any case it is highly desirable to remove every trace of grease from the feed-water. As already stated, this cannot be done by filters; and grease separators, which appear to be rather more efficient, do not remove the last trace of grease.

As yet the only effective method for doing this is to add mineral matter in solution to the condensed water and then to cause precipitation by chemical means. The grease then adheres to the precipitate and can easily be removed by settlement or filtration. Water from jet condensers contains the necessary mineral matter, but this has to be added, if the waters are drawn from surface condensers.

With waters of 10° temporary hardness 1.14 lbs. of caustic soda of 77% strength, or 0.8 lbs. of burnt lime, will suffice for 1,000 gallons of water. The same quantities will also neutralize all the free carbonic acid represented by 6 grains per gallon. As the prices of caustic soda and lime stand in the ratio of 12s. 6d. to 1s. per cwt., the relative costs of the two treatments would be 1.53 (3 cts.) and 0.09 (0.18 ct.) penny per 1,000 gallons, and naturally one would use caustic soda only if it is a waste product and if there is permanent hardness also present. Large proportions of soda, either carbonate or caustic, affect brass fittings.

It requires 1.5 lb. soda ash of 58% strength to remove 10° permanent hardness out of 1,000 gallons; as the price

of this soda is about 5s. 6d. per cwt. the cost would be about 0.88 penny (1.76 cts.) per 1,000 gallons. The strength of washing soda is about 20 to 22%.

In some water softeners, such as the Archbutt-Deeley, Lässen and Hjort, caustic lime and carbonate of soda are mixed, producing a milky fluid, which consists of caustic soda, free lime or free soda ash, and insoluble carbonate of lime, the latter substance being of course a useless constituent. The cost of the caustic soda so produced would be about 6s. per cwt.

The interest and depreciation of the softening plant, the attendant's time, generally only half-an-hour a day, have to be added to the above expenses. If the waters are treated in the boilers—when burnt lime may, of course, not be used—the cost of removal of the scale and the wear and tear of the boiler, due to overheating, have to be added.

We have now to turn our attention to some of the practical difficulties which water softeners have to overcome, the most important of these being the proper adjustment of the supply of chemicals and the removal of the precipitates from the treated waters. If, by suitable chemicals, we precipitate carbonate of lime out of water, it is at first in a colloidal condition, its first appearance being that of a bluish-white thin starch, which can freely pass through the best chemical filters, and could never be arrested by wood wool, cloth or sponges. If this fluid is allowed to stand for a considerable time, or if it is heated a little, the precipitate settles down, changing to a yellowish color, and no amount of shaking will again convert it back to its original condition; but even now this precipitate is so fine that it settles down very slowly. According to Professor Wanklyn's experiments this precipitate will settle down in 25 minutes through ¾-in. of water, which will then be quite clear, whereas it takes eight hours to clear 20 ins. of water charged with this precipitate. The rate of settlement is about 1.8 to 2.5 ins. per hour. No experiments seem to have been made on hot water.

It is thus understood why very large tanks are necessary when working with cold water, and why even filters will not remove all the precipitated carbonate of lime. When the softening operation is carried out hot, these settling tanks, as can be seen by comparing various softeners, may be much reduced in size, and filters now become far more effective than before.

In most of the cold-water softeners the treated water moves upwards against the descending sediment, which, being coarse, assists the newly-formed precipitate in settling down. In other softeners, notably in that of Desrumaux, the treated water is made to travel in comparatively thin sheets. Thus by dividing the tower into narrow layers, the precipitate has not to fall very far. This principle may be carried too far, for the thinner and longer the sheet of water, the greater the velocity and the stronger the eddies.

In spite of the use of very large settling tanks, supplemented by filters, there are very few cold-water softeners which can be relied upon to remove all the solid matter which the added chemicals have precipitated, and serious complaints are not infrequently heard that after the installation of a water softener, the injectors or the feed pipes get choked with scale. Evidently all the chemical precipitates do not settle down thoroughly until the comparatively hot pipes are reached.

To overcome this difficulty the Archbutt-Deeley process is arranged so that the carbonic acid gas from a stove comes in contact with the treated water and dissolves the trace of precipitate which would have appeared in the pipes. Steam users, however, have a prejudice against deliberately introducing carbonic acid into their boilers, and some at least add very large settling tanks, and do not use the stove. Unquestionably the most effective way of removing the residual precipitate would be to heat the treated water, but as already shown, that is a very expensive remedy.

In practice, magnesia precipitates are still more difficult to deal with than the lime precipitates, because of their gelatinous nature, which although it assists in separating out the carbonate of lime, also retards the settling process, and seriously interferes with the working of filters. Here again heat is a remedy, but only a partial one, and is very costly. Nevertheless, several of the softeners dealt with in this paper seem to have removed large quantities of magnesia without choking their filters.

In the Archbutt-Deeley softener, which, due to a sufficiency of lime, has effectively removed nearly all magnesia salts, each new tankful of treated water is mixed with the sediment of the previously treated waters, the settlement being expedited by the adhesion of the old and coarse particles to the new flocculent and gelatinous precipitates. The same principle is adopted in those softeners in which the treated water is led to the bottoms of the settling tanks, and has to pass through previously precipitated mud. Use is also made of the precipitated mud for the removal of grease in the apparatus of Babcock & Wilcox, Boby, Maxim and Wollaston, in which exhaust steam is introduced. The explanation of the cause of this removal is doubtless to be found in the coagulation of the first-formed colloidal precipitate, which on separating effectively removes both the oil in suspension and in the emulsified state. Wollaston finds that the greasy scum rises upwards, and at the top of his reaction tower a scum tap is fitted, and the exit from this tower to the settling tank is placed some distance below, thereby preventing this scum from contaminating the softened water.

Out of 17 continuous water softeners dealt with in this paper 14 are fitted with filters. Two of these, Bell's and Reisert's, are sand filters. Porter-Clark and Atkins have cloth filters, and the others have wood wool or sponge filters. Wood wool is cheap and can be renewed, say, twice a year, while sponges have to be cleaned. These removal or cleaning operations are rather tedious, but cannot be entirely obviated. Those filters through which the

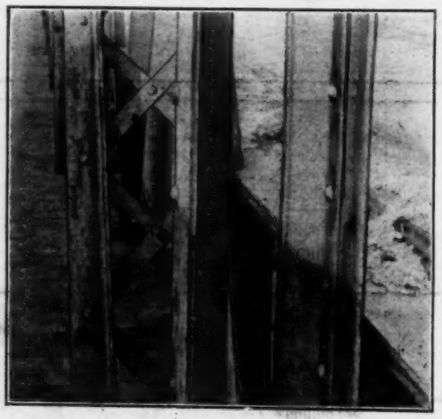


Fig. 1. View Showing Diagonal of a Highway Bridge Truss Fused by Short-Circuited Electric Current.

water passes downward, and on to which the sediment falls, have, of course, to be cleaned much more frequently than those through which the water passes upward.

Cloth filters have to be cleaned by hand. They generally consist of a number of wooden or iron frames, each frame being separated from its neighbor by a piece of cloth. The frames are pressed together by two long bolts. The water enters every alternate frame through a hole in the top side or middle, and is discharged out of holes in the bottoms of the adjoining frames. The cloths are easily removed by slacking back the nuts on the long bolts. The Atkins filters are circular disks which are brushed clean without removing them.

The second difficulty encountered in practice is that of properly apportioning the chemicals. It appears that in all water softeners the chemicals are dissolved in water or at least mixed with it, and the introduction of small measured quantities of powdered slaked lime and of powdered soda does not appear to have been tried, and numerous complicated and ingenious contrivances have been devised for overcoming the difficulties which are encountered when using fluids.

Thus, caustic lime dissolves only very sparingly in water, the quantity decreasing with rising temperature from 91 grains at 60° F. down to 40 grains at 212° F.

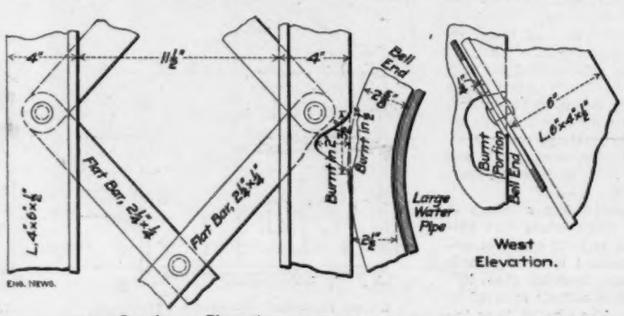



FIG. 2. SKETCHES SHOWING NATURE AND EXTENT OF FUSED DIAGONAL AND ADJACENT PIPE.

At about 70° F. the solubility decreases at the rate of about ½% for every 1° F. rise of temperature. It requires 1¼ grains of caustic lime, or about 1-70-gallon of lime water to precipitate the carbonate of lime, which is dissolved in water containing 1 grain of a free carbonic acid, and as this free carbonic acid is rarely less than 7 grains per gallon it is generally necessary to add quite 10% of lime water. This lime water is prepared by throwing slaked lime into a deep tank and letting unsoftened water flow slowly through the milk of lime in the bottom. If the flow is slow enough and the tower high enough, the overflow is clear saturated lime water. The relative quantity of lime water to untreated water is regulated by letting both streams emerge from a single tank having adjustable nozzles or weirs. Except that the lime tank must be high, and that it ought to be provided with stirrers near the bottom, this arrangement is a fairly convenient one. It is used by Atkins, Desrumaux, Reisert and Stanhope.

The apparatus can, of course, be made much smaller if milk of lime, containing say 10% caustic lime, is used instead of clear lime water, but then it is imperative that this milk of lime should be perpetually stirred, as in the Bell, Doulton, Harris-Anderson and Porter-Clark softeners, nor is it permissible to add water during the working day, as appears to be the case with the Harris-Anderson softener. The mixture is thereby made weaker and weaker.

In the Lassen & Hjort softener the quantity of milk of lime and soda solution, injected with each tilt of the water trough, is regulated by the duration of the opening of a small valve, but as the head of the reservoir diminishes during the working day, so does the quantity of injected fluid, and it has been found necessary to keep the chemical tank half full. These two examples will suffice to show that, in spite of some advantages, the use of milk of lime is perhaps attended with more difficulties than is the use of lime water.

Most water softeners are provided with small lime-slaking tanks, but this is not an invariable practice nor does any continuous softener seem to be fitted with a tank in which either soda or caustic soda is dissolved before use; yet it takes some time to dissolve these salts and thoroughly mix the solutions. The addition of the soda to the untreated water is perhaps most easily effected by a small pump, which must be of iron, working in unison with the feed-pump. Scoops and bucket-chains are also used. In all these arrangements the ratio of soda to water is best regulated by varying the strength of the soda solution. The Harris-Anderson softener has a very ingenious arrangement for delivering soda of the right density. It is, however, questionable whether all these extremely ingenious contrivances are at all necessary. They are intended to replace the pump, but have grown so complicated that they are unquestionably now more costly. Pumps for supplying the chemicals are used by Bell, Boby, Maxim, Porter-Clark and Wollaston. Weirs, whose relative widths can be regulated, are used by Harris-Anderson and Wright. Carefully gaged holes or taps, whose openings can be regulated, are used by Babcock & Wilcox, Carrod, Desrumaux, Doulton, and ball taps by Atkins and Tyake.

## A CURIOUS ACCIDENT FROM SHORT-CIRCUITED ELECTRIC CURRENT.

The accompanying view and sketches show a curious instance of damage to a highway bridge at Lawrence, Mass., due to a current of electricity having become short-circuited by the slipping of a trolley car arm. The bridge crosses the Merrimac River and carries, besides the electric railway track and street traffic, a 16-in. water main located just outside of one of the trusses and protected by a wooden boxing. While an electric car was crossing the bridge the trolley arm accidentally came in contact with the truss, and the current followed one of the diagonals down to the bell end of one of the lengths of water pipe, where it came close to the truss, and jumping the intervening space formed an arc, which did the damage illustrated.

Fig. 1 is a view from a photograph showing the damaged diagonal and the adjacent pipe. The sketches in Fig. 2 show the nature and extent of the damage in more detail. In commenting on this accident Mr. R. A. Hale, M. Am. Soc. C. E., Principal Assistant Engineer, Essex Co., Lawrence, Mass., who sends us the photograph and the sketches reproduced here, says:

> The current nearly burned through one leg of the angle and melted the side of the pipe for a distance of 6 ins. before the current was shut off. I do not know the length of time the current was passing to produce this effect but should judge from witnesses who were passing that it must have been two or three minutes and the appearance was a bright electric arc with the molten iron dropping rapidly. The strut has been repaired by bolting a strap of iron along the side. I do not know whether such occurrences are common and I do not know of its happening in this vicinity before. The planking of the bridge has caught fire several times from imperfect connection of wires.

Chas H. Hamill